GENERAL REPORT

SURVEY OF INDIA

1883-84 and 1884-85

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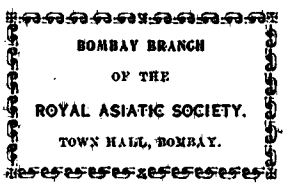

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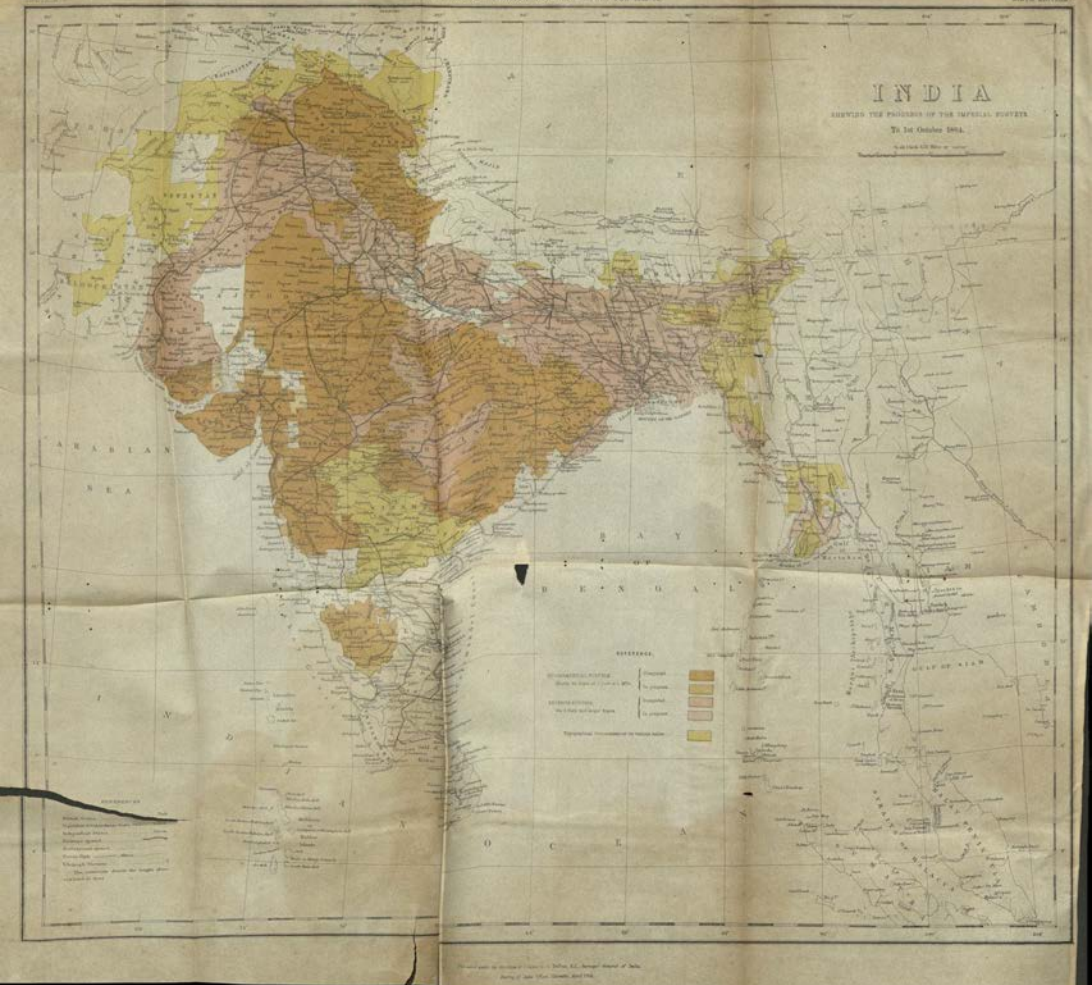
INDIA
SHEWING THE PROGRESS OF THE IMPERIAL SURVEYS
To 1st October 1883.
REFERENCE.
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN

GENERAL REPORT

ON THE

Operations of the Survey of India Department,

ADMINISTERED UNDER THE GOVERNMENT OF INDIA

DURING

1883-84. & 1884-85

134587

PREPARED UNDER THE DIRECTION

OF

COLONEL G. C. DEPRÉE, S.C.,
Surveyor-General of India.

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Calcutta:
BENGAL SECRETARIAT PRESS.
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CONTENTS.

PART I.

INTRODUCTION.

	Pages.
Director and Administrative Officers of the Survey of India	1
Statement of Survey Operations and Parties	2
Triangulation	4
Special operations	*ib.*
Topography	*ib.*
Mouzawar, Riverain, and Forest Surveys	5
Cadastral Surveys	6
Training of officers of the Civil Service and of Military students	7
Geographical explorations and reconnaissance	*ib.*
Inspections by the Surveyor-General and Deputy Surveyors-General	8
Technical offices	9
Exhibits at the Calcutta International Exhibition	*ib.*
General remarks	10

PART II (and Appendix).

SUMMARY OF THE OPERATIONS OF THE TRIGONOMETRICAL, TOPOGRAPHICAL, REVENUE, AND EXPLORATION SURVEY PARTIES.

	Pages. Report.	Appendix.
Triangulation.		
Coast, Orissa, and Ganjam	14	i
Topography.		
Aligarh and Etah districts	12	...
Andaman	13	iii
Assam and North-East Frontier	14	vii
Baluchistan	15	x
Gutch	16	...
Guzerat	17	xi
Malwa	18	xii
Mirzapur	19	xvi
Mysore	20	*ib.*
Rajputana	21	xvii
South Deccan	22	...
Mouzawar and Forest Surveys.		
Burma Forests	23	xvii
Hissar district	26	...
Thana district (Bombay)	27	xx
Cadastral Surveys.		
Ajmere-Merwara district	28	...
Bassein and Henzada districts	30	...
Benares and Basti „	32	...
Chhattisgarh division	34	...
Dehra Dún district	37	...
Gorakhpur district	39	xxi
Kamrup „	43	xxiii
Pegu and Shwegyin districts	45	...
Prome and Akyab „	47	...
Geographical and Miscellaneous.		
Aka and Daphla	7	...
Dardistan and Chilas	8	xxiv
Kafiristan	7	...
Kakar Tribes	...	xli
Kashmir	...	xxvi
Sikkim, Darjeeling, and Nepal boundary	50	xxviii
South-West Baluchistan	8	xxxvi
Takht-i-Suliman	15	xxxviii
Tibet and Mongolia	7	xliv
Tidal and Levelling Operations.		
Tidal operations	52	xlviii
Spirit-levelling operations in connection with Tidal operations	53	...
Spirit-levelling operations in connection with Revenue Surveys	54	...
Geodetic.		
Electro-telegraphic determinations of longitudes	*ib.*	lxix

PART III (and Appendix).

SUMMARY OF THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

	Pages. Report.	Appendix.
1.—Survey of India Offices, Calcutta—		
Surveyor-General's Office .	57	...
Topographical Survey Branch Office	58	...
Revenue Survey Branch Office	*ib.*	...
Map Record and Issue Office	*ib.*	...
Drawing and Geographical Office	59	lxxxiii
Examining Office . .	59	xcvi
Engraving Office . .	61	xcvii
2.—Lithographic Office . .	*ib.*	ci
3.—Photographic Office . .	62	cvi
4.—Mathematical Instrument Office	65	...
5.—Trigonometrical Survey, Branch Office, Dehra .	67	cxi

Appendix.

TABULAR STATEMENTS AND MISCELLANEOUS.

	Pages.
Outturn of Field work executed by the Trigonometrical, Topographical and Revenue Branches	lxxviii
Table of cost-rates of the Field-work of the three Branches .	lxxx
Abstract of areas and cost-rates according to jurisdictions (Revenue Branch)	lxxxi
Districts completed since last report, with Table of costs, (Revenue Branch) . . .	*ib.*
Statement of principal records prepared in the Field-party offices (Revenue Branch) . . .	lxxxii
Memorandum on the principles for conducting work of Settlement and Survey in Gorakhpur.	cxxiv
Note on procedure in ditto for the preparation of Records-of-Rights	cxxv
Letter No. 72—*I-I*, dated 11th February 1884, from Settlement Officer, Gorakhpur, to the Commissioner, Benares Division .	cxxvi
Board's letter No. 136—IX, 19, dated 7th March 1884, to the Commissioner, Benares Division	cxxix
Letter No. 55—IC, 2, dated 15th November 1884, from the Settlement Officer, Gorakhpur, to the Judge of Gorakhpur . .	*ib.*
Letter No. 49—ID, 2, dated 13th November 1884, from the Settlement Officer, Gorakhpur, to the Officer in charge, No. 5 Party, Revenue Branch . .	cxxx
Letter No. 79—IA, 6, dated 1st December 1884, from the Settlement Officer, Gorakhpur, to the Officer in charge, No. 5 Party, Revenue Branch . .	cxxxi
Revised rules for working the Settlement and Survey in Gorakhpur, 1884-85 . . .	*ib.*
Extract from the Official Report of the Calcutta International Exhibition Committee . .	cxxxiii

LIST OF MAPS.

	Pages. Report.	Appendix.
Index showing progress of Imperial Surveys	Frontispiece.	
Triangulation.		
Index chart of Triangulation of the Great Trigonometrical Survey of India . . .	4	...
Topographical.		
Index to the sheets of the Aligarh and Etah Survey . . .	12	...
Index to the sheets of the Andaman Survey	13	...
Index to the sheets of the Assam and North-Eastern Frontier Survey	14	...
Index to the sheets of the Baluchistan Survey	15	...
Index to the sheet maps of the N.-W. Trans-Frontier . .	*ib.*	...
Index to the sheets of the Catch Survey	16	...
Index to the sheets of the Guzerat Survey	17	...
Index to the sheets of the Malwa Survey	18	...

LIST OF MAPS—*concluded.*

	Pages. Report.	Appendix.
Index to the sheets of the Mirzapur Survey	19	...
Index to the sheets of the Mysore Survey	20	...
Index to the sheets of the Rajputana Survey	21	...
Index to the sheets of the South Deccan Survey	22	...
Mouzawar and Forest Surveys.		
Index to the sheets of the Burma Forests Survey	23	...
Index to the sheets of the Hissar district Survey	25	...
Index to the sheets of the Konkan, Thana district Survey	22	...
Cadastral Surveys.		
Index to the sheets of the Ajmere-Merwara district Survey	28	...
Index to the sheets of the Bassein and Henzada districts Survey	30	...
Index to the sheets of the Benares district Survey	32	...
Index to the sheets of the Basti district Survey	*ib.*	...
Index to the sheets of the Chhattisgarh division, Raipur district Survey	34	...
Index to the sheets of the Dehra Dún district Survey	37	...
Index to the sheets of the Gorakhpur district Survey	39	...
Soil map of Tehsil Deoria, district Gorakhpur	41	...
Index to the sheets of the Kamrup district Survey	43	...
Index to the sheets of the Pegu and Shwegyin districts Survey	45	...
Index to the sheets of the Prome district Survey	47	...
Index to the sheets of the Akyab district Survey	*ib.*	...
Geographical and Miscellaneous.		
Arcs of longitude determined through the electro-telegraph operations	54	...
Index of the Indian Atlas, showing sheets published up to October 1884	59	...
Index of the Indian Atlas, showing the state of the engraving up to October 1884	61	...
Map of the Volcano of Barren Island	...	iv
Map of the Volcanic Island of Narcondum	...	v
Sketch map illustrating the explorations in Dardistan	...	xxiv
Map illustrating the expedition to the Takht-i-Sulimán	...	xxxviii
Sketch map illustrating the explorations of the Lama in parts of Tibet, Sikkim, and Bhutan	...	xliv

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1883-84.

PART I.

INTRODUCTORY.

THE general direction of the Survey of India Department during the year 1883-84 continued to be carried on by Colonel G. C. DePrée, B.S.C., who, upon the retirement of Lieutenant-General J. T. Walker, C.B., R.E., LL.D., F.R.S., &c., on the 12th January 1884, received the permanent appointment of Surveyor-General of India. The superintendence of the Topographical Branch, consisting of eight field parties, was also held by Colonel DePrée throughout the year.

2. On the same date, Mr. J. B. N. Hennessey, M.A., F.R.S., &c., then officiating as Deputy Surveyor-General in charge of the Trigonometrical Branch, was confirmed in that office. On the 5th March 1884, Colonel J. Sconce, B.S.C., proceeded on furlough, and, creating a vacancy amongst the three administrative officers, Lieutenant-Colonel H. R. Thuillier, R.E., Deputy Superintendent, 1st grade, was appointed to officiate as Deputy Surveyor-General in charge of the Revenue Branch, until the retirement of Mr. Hennessey on 1st October 1884, when he succeeded to the permanent office. To fill the vacancy caused thereby, Colonel C. T. Haig, R.E., Deputy Superintendent, 1st grade, was appointed to officiate as Deputy Surveyor-General in charge of the Trigonometrical Branch.

3. The Surveyor-General accompanied the Government of India during its location in Calcutta and Simla, except when he was engaged on inspection tours. The Deputy Surveyor-General in charge of the Revenue Branch continued in Calcutta, except when summoned to attend a conference at Simla, and subsequently at Naini Tal, when on inspection duty. The Deputy Surveyor-General in charge of the Trigonometrical Branch spent seven months at the hill station of Mussooree, and five months at his head-quarters at Dehra, an arrangement carrying with it a certain inconvenience, as the important offices at the latter station require the constant presence of a directing officer.

4. The large Technical, Correspondence, and Accounts offices situated in Calcutta were administered under the direction of the Surveyor-General by Major C. Strahan, R.E., Assistant Surveyor-General in charge of the Drawing and Engraving offices; by Major J. Waterhouse, B.S.C., in charge of the Photo-zincographic and Lithographic with Type-printing offices; and by Major M. W. Rogers, R.E., in charge of the Surveyor-General's Correspondence and Accounts offices, and of the Mathematical Instrument office. Captain St. G. C. Gore, R.E., performed the duties of Personal Assistant to the Surveyor-General until he joined the Afghan Boundary Commission; and Lieutenant-Colonel W. H. Wilkins assisted in the office of the Revenue Survey, and superintended the Map Record and Issue office, and the preparation of an official catalogue of published maps.

5. During the past year the connection of five officers with the department has closed. On the 12th January 1884, Lieutenant-General J. T. Walker, C.B., R.E., LL.D., F.R.S., &c., retired from the army after a service of 41 years, during 31 of which he had directed his energies towards the advancement of the knowledge of geography inside and beyond India, and to the continuation and

completion of that great work, the Great Trigonometrical Survey of India, the last field operations of which closed in 1881. On the retirement of General Sir A. Waugh, R.E., in 1861, General Walker succeeded to the administrative post of Superintendent of the Great Trigonometrical Survey. In 1878 he assumed the additional functions of Surveyor-General of India on the retirement of General Sir H. E. L. Thuillier, C.S.I., as well as administered the Topographical Branch until shortly before proceeding on furlough at the beginning of 1883. The Government of India have recorded the sense they entertain of the long and distinguished services of General Walker, especially in connection with the Great Trigonometrical Survey, by a Government of India notification.* The Secretary of State has also expressed† his appreciation of the able way in which, as Surveyor-General, he directed the department.

* No. 1693, dated 9th May 1884.
† Despatch No. 127, dated 2nd October 1884.

Mr. J. B. N. Hennessey, M.A., F.R.S., entered the Survey Department in 1844, and was promoted to the senior branch in 1854, since which time he has been connected with the offices at Dehra, and especially with the Computing office, which he superintended for many years, until eventually in 1883 he succeeded to the administration of the Trigonometrical Branch as Deputy Surveyor-General. On the 1st October 1884 he retired from the service, and has been awarded a special superannuation pension in recognition of his high scientific acquirements and long and faithful services.

Major R. V. Riddell, R.E., Assistant Surveyor-General, who had been for several years attached to the head-quarter's offices at Calcutta, left the department this year on being appointed Master of the Calcutta Mint.

Mr. J. O. N. James, for many years an Assistant Surveyor-General in charge of the Drawing and Map Issue offices at the Presidency, retired on being superannuated on 7th August 1884, thus ending a career of much usefulness.

In the junior branch five surveyors and assistant surveyors ceased to belong to the department, either by death, retirement, or other cause.

6. It will be an object in this report to place together particulars of a like nature, so that the results obtained by field parties, though belonging to the three branches and administered by the three Deputy Surveyors-General separately, may be comparable with one another, thus emphasizing the policy of a complete amalgamation of the three branches of Trigonometrical, Topographical, and Revenue Surveys. A tabular statement of outturn of work appertaining to all field parties, and one of cost rates will therefore be found in their appropriate places. This report also will be more conveniently indexed than heretofore; otherwise it will follow the arrangement adopted in the General Report of the Operations of the Survey of India for 1882-83 and preceding seasons.

7. The operations carried on during the year, or from 1st October 1883 to 30th September 1884, by the several field parties, numbering 26 of full size and 3 detachments, are shown in the following tabular statement:—

Statement of Survey Operations and Parties.

Name and *locale* of operation.	Pages in this Report.	Name of executive officer.	Designation of survey party.	Scale of Survey.
Triangulation.				
Coast, Orissa and Ganjam.	11	Mr. A. D'Souza ...	Secondary Triangulation.	
Topography.				
Aligarh and Etah districts.	12	Mr. J. O. N. James and Major E. H. Steel, R.E.	No. 2 Rev. Branch...	2″=1 mile for reproduction and reduction to 1-inch scale.
Andaman	13	Captain J. R. Hobday, R.E.	No. 4 Topo. Branch	8″=1 mile for reproduction and reduction to 1-inch scale and 4″=1 mile for reproduction.
Assam and North-East Frontier.	14	Lieut.-Colonel R. G. Woodthorpe, R.E.	No. 6 Topo. Branch	1″=4 miles and 3″=2 miles for reproduction.
Baluchistan	15	Lieutenant the Hon'ble M. G. Talbot, R.E.	No. 3 Topo. Branch	2″=3 miles, 1″=4 miles, and 1″=2 miles for reproduction.

Nature and *locale* of operations.	Pages in this Report.	Name of executive officer.	Designation of survey party.	Scale of survey.
Cutch	16	Lieut.-Colonel A. Pullan, s.c.	Cutch Survey ...	2″ = 1 mile for reduction to 1-inch scale and ½″ = 1 mile for reproduction.
Gurzerat	17	Colonel C. T. Haig, r.e., and Lieut.-Colonel W. F. Badgley, s.c.	Gurzerat Survey ...	4″ = 1 mile and 2′ = 1 mile for reproduction and reduction to 1° scale.
Malwa	18	Major T. T. Carter, r.e. ...	No. 2 Topo. Branch	1″ = 1 mile for reproduction.
Mirzapur district ...	19	„ J. R. Wilmer, s.c. ...	No. 5 Topo. Branch	2″ = 1 mile for reproduction and reductions to 1-inch scale.
Mysore	20	Lieut.-Colonel H. R. Thuillier, r.e., and Major J. R. McCullagh, r.e.	No. 8 Topo. Branch	1″ = 1 mile for reproduction.
Rajputana	21	Major R. Beavan, s.c. ...	No. 1 Topo. Branch	1″ = 1 mile, 2″ and 12″ = 1 mile for reproduction.
South Deccan ...	22	Major D. C. Anderson, s.c. ...	No. 11 Rev. Branch	2″ = 1 mile for reduction to 1-inch scale.
Mouzawar, Rivers-in and Forest Surveys.				
Burma Forests ...	23	Mr. H. Hörst	No. 7 Topo. Branch	4″ = 1 mile and 2′ for reproduction.
Hissar district ...	25	Lieut.-Colonel D. McDonald, s.c., and Lieut.-Colonel F. Coddington, s.c.	No. 1 Rev. Branch	12′ and 6″ = 1 mile for reproduction, and 2″ = 1 mile for reproduction and reduction to 1-inch scale.
Thana district ...	27	Major J. Hill, r.e., and Mr. A. M. Lawson.	No. 10 Rev. Branch	4″ = 1 mile for reproduction and reduction to 1-inch scale, and 2″ = 1 mile for reduction to 1-inch scale.
Cadastral Surveys.				
Ajmere-Merwara district ...	28	Mr. A. J. Gibson. ...	Ajmere detachment — (No. 1 Rev. Branch).	16″ = 1 mile skeleton traverse survey.
Bassein and Henzada districts.	30	Major H. S. Hutchinson, s.c.	No. 8 Rev. Branch	16″ = 1 mile for reproduction and 2″ = 1 mile for reproduction and reduction to 1-inch scale.
Benares and Basti districts	32	„ S. H. Cowan, s.c. ...	No. 4 Rev. Branch ...	16″ = 1 mile for reproduction and 2″ = 1 mile for reproduction to 1-inch scale.
Chhattisgarh Division ...	34	Mr. P. A. G. Cowley ...	Chhattisgarh detachment — (No. 3 Rev. Branch.)	16″ = 1 mile, test survey, and 16″ = 1 mile blocks for settlement survey.
Dehra Dún district ...	37	„ W. A. Wilson ...	Dehra Dún detachment — (No. 3 Rev. Branch.)	16″ = 1 mile for reproduction.
Gorakhpur district ...	39	Major J. E. Sandeman, s.c.	No. 5 Rev. Branch ...	16″ = 1 mile for reproduction and 2″ = 1 mile for reduction to 1-inch scale.
Kamrup district ...	43	Mr. E. C. Barrett ...	No. 6 Rev. Branch ...	16″ = 1 mile for reproduction and reduction to 2″ = 1 mile 1-inch scale.
Pegu and Shwegyin districts	45	Major J. R. McCullagh, r.e., and Mr. E. J. Jackson.	No. 2 Rev. Branch ...	16″ = 1 mile for reproduction and 2″ = 1 mile for reproduction and reduction to 1-inch scale.
Prome and Akyab districts	47	Mr. H. B. Talbot ...	No. 7 Rev. Branch.	16″ = 1 mile for reproduction to scale and 2″ = 1 mile for reproduction and reduction to 1-inch scale.
Geographical and Miscellaneous.				
Aka and Dophla	7	Lieut.-Colonel R. G. Woodthorpe, r.e.	... ...	
Dardistan, Chilas, and Kashmir.	8	Native Surveyor ...	Detachment ...	
Kafiristan,* Dir Chitral ...	...	Mr. W. W. McNair ...	Exploration ...	Confidential.
Sikkim, Darjeeling and Nepal boundary.	50	Lieut.-Colonel H. C. B. Tanner, s.c.	Darjeeling Survey ...	8′ = 1 mile, 1° = 1 mile and 4° = 2 miles for reproduction.
South-West Baluchistan ...	8	Lieutenant the Hon'ble M. G. Talbot, r.n.	Detachment ...	
Takht-i-Sulaiman ...	15	Major T. H. Holdich, r.e.	Detachment ...	
Tibet	7	Lama, U.G. ...	Exploration ...	
Tidal and Levelling Operations.				
Tidal operations ... Spirit levelling ...	52	Majors A. W. Baird, r.e., and J. Hill, r.e., and Mr. H. E. T. Keelan.	Tidal and levelling Party.	
Geodetic.				
Electro-Telegraphic determinations of longitude.	54	Majors G. Strahan, r.e., and W. J. Heaviside, r.e.	Nos. 1 and 2 Astronomical Parties.	

* An explorer in service of Educational Department

TRIANGULATION.

8. The preceding General Report of the Survey of India pointed out the several operations under contemplation at the end of 1882-83. They consisted of a secondary series along the coast of Orissa dependent on the great triangulation, with the object of fixing the position of the False Point Light-house and a system of fixed beacons for the use of the Marine Survey, and in aid of ocean navigation. This work has been successfully carried on during the season, and will be continued for some seasons longer until outlying foreshores on the eastern coast of India have been accurately marked. A second but very important secondary series for connecting India with the settlements of the Straits of Malacca has remained in abeyance, and it cannot at present be undertaken owing to the numerous calls elsewhere upon the officers and men of the Survey of India for other more urgent work. The project has, however, by no means been lost sight of.

SPECIAL OPERATIONS.

9. The two Astronomical Parties continued to work in concert in determining the differences of longitude between stations a few hundred miles apart. The series of arcs dealt with were those on the east of Calcutta; and the longitude of Moulmein has now been accurately determined with reference to Greenwich.

10. During the year the latest and probably final value of the longitude of the Madras Observatory, from which the time for all the trunk railways is regulated, was circulated to officials and to the world. A suitable note giving this value, viz. 80° 14′ 51″, and stating what correction is necessary to the meridians as shown on the published maps, will in future be attached to every atlas sheet or chart. The Tidal and Levelling Party has continued its operations. Automatic records are in constant progress at 19 observatories on the coasts of the Indian seas between Aden and Burma. Two new observatories have been erected in Ceylon, and are now maintained at the expense of the Government of India. The predictions of tides at many of the principal ports are now printed in convenient form, and are issued to the public for each year a few months in advance.

TOPOGRAPHY.

11. The regular topographical operations have been continued so as to further fill in the blank areas of unsurveyed country on the face of India. The country delineated consisted of portions of the Andaman Islands, Assam, Baluchistan, the forests of British Burma, Central India, Cutch, Guzerat, Malwa, Mirzapur, Mysore, Nepal Frontier, North-West Provinces, South Deccan, and the Punjab. The Mirzapur Party, in addition to detail delineation of natural features, carried on a system of traverses so as to regulate surveys made by the Settlement Agency. The Kohat Party ceased to exist, and became merged in the Baluchistan Survey. The members of the combined party were then formed into separate detachments, one of which executed a special survey under a large military escort from the summit of, and round about, the Takht-i-Suliman range; a second, accompanying the friendly mission of Sir R. Sandeman into the south-western tracts of Baluchistan, carried on a double series of triangulation from previously fixed points in Peshin to Panjgur, the capital town of that desert region, the position of which had been approximately determined by travellers starting from the sea coast. At the same time the two officers engaged made a detailed survey of the country embraced in that triangulation. Next, a native surveyor pushed across the frontier from the side of India, and continued the survey of that line, extending in a belt as far as the summits of the main mountain range running parallel to the border. In the meanwhile the other members of the party continued to add to the general topography of Baluchistan within the limits of British control.

12. The Assam Party had actually taken the field, and was marching with the object of surveying that unknown tract on the extreme east of Assam extending from Sadiya to the Burmese frontier, within the space of which,

INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA

it is believed, will be found the now forgotten road whereby the armies of the last-named power entered and retreated from Assam during their occupation of the country in the early part of this century. But it was suddenly diverted by the necessity which arose of sending a military force to chastise the hill tribe of the Akkas, and the party therefore advancing with the field force, and aiding it with their organized transport of carriers, mapped the entirely unknown country falling under their vision and limited by the distance traversed by the field force. This expedition being over, the surveyors employed themselves in adding to our knowledge of the mountain region bordering on Assam inhabited by the Daphlas and tribes on the east and west of the Akka country. Thus the North-Eastern or Assam frontier is becoming gradually less of a *terra incognita*.

13. The Andaman Party has connected the adjacent islands by a triangulation, and has mapped a good portion of ground on a large scale about the settlement, and the uncleared portions have been delineated on the usual scale so as to form a geographical map, to be supplemented eventually by a marine survey. Barren island and Narcondum, volcanic peaks rising from the sea near the Andaman group, have been delineated.

14. The Darjeeling Party has completed the survey of the Daling hills on the east of the Northern Bengal State Railway, as well as the survey of the boundary of Nepal between the Kossee and Gandak rivers.

MOUZAWAR, RIVERAIN, AND FOREST SURVEYS.

15. In the Punjab the survey of district Hissar has been completed on the system described at page 4 of the General Report of last year. This system provided an elaborate basis of permanent marks at half-mile intervals for a subsequent Cadastral Survey of fields to be carried out by the Settlement Department. On financial and other grounds, the Punjab Government has demanded the restriction of the scientific work to the lowest necessary limit in future, and it has been decided on the joint proposals of the Commissioner of Settlements, Punjab, and the Surveyor-General, to reduce the frame-work of traverses and to compile new Standard Sheets of the Punjab, by taking the topography from the settlement maps surveyed by the village *patwaris*, a novel experiment, the results of which will be watched with interest, and one which can only be practicable in an open and featureless country, such as the Punjab is. In the alluvial basins of the great rivers, however, a more complete survey has been determined on, in which the boundaries of the village lands are to be surveyed by professional surveyors, and a series of marks are to be fixed on the permanent lines of the boundaries on both banks beyond the influence of floods.

16. The Riverain Survey on the 4-inch scale, along the Ganges river, conterminous with the topographical operations in districts Aligarh and Etah, has been continued, embracing the village lands lying opposite thereto in district Budaun. A similar Riverain Survey on the Gogra river, which was commenced during the previous season in connection with the Cadastral Survey of district Ballia, has been carried on by the party working in the Gorakhpur district in the lowlying lands of the Ballia and Azamgarh district, as far as the cadastral operations have extended.

17. The survey of the Thana district has been continued for forest purposes by the Konkan Party on the scale of 4 inches to the mile. This undertaking will be completed during the current year, when the party will be transferred to the Southern Mahratta country.

18. The most intricate and difficult survey of the forests on the west of the Yoma range in British Burma has been advanced under the conditions explained in the previous report of this department.

19. The areas of all these operations are—

	Square miles.
Mouzawar	1,782
Riverain	310
Forest	875

CADASTRAL SURVEYS.

20. In the North-West Provinces the Cadastral Survey of the Benares district, including the domains of the Maharaja of Benares, has been completed, and the party engaged thereon has commenced operations in district Basti. The party that was employed in Mirzapur during the previous season has commenced the Cadastral Survey of district Gorakhpur.

21. In the Benares and Basti surveys, the system followed is that known as the Benares system, which was described in the last Annual Report, pages 26 and 27, under which the Survey and Settlement establishments work together, each preparing its own copy of the *khasra* and *jamabandi*. The results in Benares confirm the anticipations of the advantages derivable by the joint inter-working of the Survey and Settlement staffs. The same system was ordered to be adopted for the Gorakhpur survey, but many important changes in the procedure have been introduced there by Mr. La Touche, the Settlement Officer, and Major Sandeman, Deputy Superintendent of Survey, which remove the chief defects of the Benares system. The basis of the Gorakhpur system is that the Survey Department is responsible for all undisputed entries in the Record-of-Rights, and furnishes a complete list of all disputes. The classification of soils and the statistics for assessment purposes are also entrusted to it. Thus the Survey Department, in addition to the map, provides complete records ready for attestation and assessment. The report on the result of the operation during the first season in Gorakhpur testifies to the success of the new system and to the expectation of securing economy, both in time and expenditure. The cost rate of all the operations undertaken by the Survey Department is $4\frac{1}{2}$ annas per acre, or only $\frac{1}{2}$ anna more than the average rate of field survey alone used to be. The total cost of the two departments cannot be given until the work of the Settlement Department is finished, but the large amount of Settlement work from which that department has been relieved must very materially reduce the cost rates which prevailed in other districts worked under the old system.

22. The hand-book of instructions that was drawn up by Major Barron for the guidance of survey parties engaged in the combined operations of survey and settlement proved to be a valuable guide; but as it was written for the procedure current in Benares, many alterations are necessary to make it accord with the procedure in Gorakhpur. Major Sandeman is now engaged in revising this manual, and with the experience gained by the working of two years, a complete and accurate guide may be expected.

23. A detachment from the Benares Party has been employed in making a Cadastral Survey, with records under the Benares system, of the cultivated areas in the Dehra Dún district. It was found that the work required to be done there had been much under-estimated, and it could not be completed in consequence during the year under report.

24. Another detachment from the Aligarh and Etah Party has been engaged in the Central Provinces on various experimental operations in the Raipur district, consisting of a Cadastral Survey of a certain number of villages as a test on the accuracy of the Settlement maps; a skeleton boundary survey embracing blocks of fields of about 80 acres, and the instruction of *patwaris* in surveying with the object of utilizing this indigenous agency under the Settlement Department to fill in the interior detail of cultivation and general topography on the skeleton maps furnished by the Survey Department. The value of the working power of this class of men remains to be proved.

25. The skeleton traverse survey of district Ajmere-Merwara has been initiated at the request of the local authorities by a small party formed by detachments from Hissar and Aligarh Parties, with the object of furnishing a basis similar to that provided in Hissar for a survey of the cultivation by *patwaris*.

26. In Assam, a new Cadastral Survey, with records under the Benares system, has been commenced in the Kamrup district by No. 6 Revenue Party, which was transferred there on the completion of the Hooghly River Survey.

27. In British Burma three cadastral parties have continued their operations in the following districts:—Pegu, Bassein, Henzada, Prome, and Akyab. All the cadastral work required in the districts of Pegu and Prome has been completed. The Local Government on financial grounds has dispensed with the Pegu party from November 1884, and has reduced the Henzada party to

half strength, which it is estimated will complete the survey of that district by October 1885. The half party that has been dispensed with has been absorbed into other parties working in India. The full party has been retained in Burma for topographical operations which will be carried on in extension of the cadastral work in the Shwegyin district. This change of plans has necessitated the breaking up of the cadastral establishment belonging to this party; the diminution of trained cadastral machinery is a matter for much regret, seeing that large demands are likely to be made on the department for cadastral surveys in Bengal.

The areas surveyed cadastrally are—

	Square miles.		Square miles.
North-Western Provinces ...	1,747	Central Provinces ...	31
British Burma	1,749	Assam	228

TRAINING OF OFFICERS OF THE CIVIL SERVICE AND OF MILITARY STUDENTS.

28. A new system for training young officers of the Civil Service in the duties of cadastral field measurements has been commenced by attaching them to the regular field parties. Thus in the North-West Provinces seven Civilians have gone through a course of instruction in field surveying by the officers of the survey. The same idea of utilizing the field parties as training schools has been developed in another direction, by attaching native soldier students of the Roorkee College to the regular field parties of the Topographical Branch, to learn the method of delineating ground by plane-table survey. Four soldiers have received such thorough training, and have been returned to the military service, their places being taken by four others, who will receive a similar training. The cost of this work is met by the general survey grant, and the additional responsibilities thus imposed on the officers of the survey should be here acknowledged.

GEOGRAPHICAL EXPLORATION AND RECONNAISSANCE.

29. The publication in a complete form of the extraordinary adventures of the explorer A—K referred to in the last General Report has served to confirm the previous estimate of the scientific accuracy of his observations, the personal endurance and fortitude displayed by him under circumstances of the greatest difficulty and danger, and generally the great value of the geographical matter, and of the addition to our knowledge of the countries of Tibet and Great Mongolia brought in by this explorer. The Government of India, on the recommendation of the Surveyor-General, have been pleased to confer on this explorer the title of *Rai Bahadur* as a personal distinction, and further have presented him with a *jagheer* of rent-free land, and have rewarded his faithful companion with a sum of money.

30. The explorer and frontier native surveyor, known as "The Bozdar," has been similarly rewarded, the title of *Khan Bahadur* having been conferred upon him together with a grant of land. It may be here mentioned incidentally that much assistance was rendered during the Aka operation by Mr. W. Penny, a planter, whose local knowledge, willingly placed at the disposal of the Survey officers, proved of great value: that assistance has been recognized by the presentation of a piece of plate.

31. The guide, companion, and friend of Mr. W. W. McNair, named "The Meah," has been rewarded also by a money grant. The publication of the report and map, the product of the remarkable expedition carried out by Mr. McNair in 1883, has now been brought out. This enterprizing surveyor, after crossing the frontier of India, accompanied by "The Syud," traversed the mountain region of Dir and Chitral, visiting in his progress the country of the Kafirs, and ascending the mountains of the Hindu Kush, and thence, carrying his life in his hand, passed through into Gilghit and Kashmir. A brief account of these exploits was afforded in paragraph 203 of the General Report of the Survey of India for 1882-83. Since then public attention has been attracted to the great interest attaching to this expedition through the account delivered by the surveyor himself before the Royal Geographical Society of London, so that it is not necessary to recapitulate here the main facts of that

expedition. It may, however, be mentioned that the learned Society just named has awarded the "Murchison grant" to Mr. McNair. The Government of India have now, on presentation of the report, expressed their high estimation of his adventurous spirit and courage, and of the value of the information presented to them by this hardy and skilful surveyor, who, accoutred with his portable sketching table and instruments for mountain reconnaissance, and aided by his native assistant who measured a continuous route along the valley, has produced a map far surpassing in accuracy any other production of the same nature.

32. The report and map of Dardistan has now been compiled and published. The inaccessibility of this tract, and its situation, as intermediate between other tracts under our influence, admitting of a survey of the valley of the Indus from distant and surrounding peaks being executed, has already been described in the report of last year at pages 6 and 40.

33. It having been decided to despatch an expedition to demarcate the Afghan frontier, on the north-west, a detachment of the Survey of India was organized to accompany it. Eventually Major T. H. Holdich, R.E., Captain St. G. C. Gore, R.E., and Lieutenant the Hon'ble M. G. Talbot, R.E., were selected, and three competent native surveyors were appointed to accompany them, named Ata Mahomed, Hira Sing, and Imam Sharif, with a complete equipment of men and instruments. Owing to the fact that this detachment now operates under the orders of the Foreign Department, and to the incessant labour the surveyors endure on their lengthy marches, and to constant occupation on their arduous duties, regular reports have not been received by the Surveyor-General, but this is the less to be regretted in that the public journals contain full accounts of their progress. The map of the early part of the journey only has been received up to this date.

34. At the same time a military expedition into the Zhob valley was taken advantage of, and preparations were made to send a second detachment of surveyors to the front, so as to map the country covered by the troops. Lieutenant R. A. Wahab, R.E., an officer young in the service, but who had already gained experience in similar work in Baluchistan, with the veteran trans-frontier surveyor Mr. G. B. Scott, and an accomplished native surveyor, Munshi E. Sharif, comprised the working power under the orders of the military commander of the expedition. The report and maps obtained have been duly received, and a tract of about 6,000 square miles of hitherto unknown country in the south-east of Afghanistan has been added to our geographical information. Full reports and details of this expedition will be given in the report for 1884-85, to which it properly belongs.

35. The general result of the topographical operations is an outturn of—

4,034·0	Square miles surveyed on the		1/4	inch scale.	
3,224·83	"	"	1/2	"	
7,436·7	"	"	1	"	
12,073·7	"	"	2	"	
691·83	"	"	4	"	
110·25	"	"	6	"	and larger scales.

INSPECTIONS BY THE SURVEYOR-GENERAL AND DEPUTY SURVEYORS-GENERAL.

36. The Surveyor-General took advantage of a conference, held in October 1883, with the Commissioner of Ajmere to examine the field offices of two topographical parties employed in Rajputana. Again on the departure of Government from Calcutta in March 1884, he proceeded on a tour of inspection to Mysore, so as to see that topographical party when in the field: he took advantage of the opportunity, and visited the Madras Observatory in charge of Mr. N. R. Pogson, the Government Astronomer, as well as the head-quarters offices of the Madras Revenue Survey under Colonel H. T. Rogers, R.E., Superintendent of Revenue Surveys. It may be noticed here that Lieutenant-Colonel Sargeaunt, Deputy Superintendent of Revenue Surveys, in charge central office, had during the previous months paid a series of visits to the offices of the Survey of India in Calcutta. During the recess Colonel DePrée proceeded again to Mussooree, and examined the offices of the several field parties, and the Trigonometrical offices at Mussooree, and

afterwards the head-quarters offices of the Trigonometrical Branch and the Forest Survey offices at Dehra.

37. The Deputy Surveyor-General in charge of the Revenue Branch inspected the offices of the field parties recessing at Naini Tal, and joined a conference held at Simla during the recess season, and the parties stationed at Poona were formally inspected during the year by the Deputy Surveyor-General in charge of the Trigonometrical Branch.

38. The Assistant Surveyor-General in charge of the Photo-zincographic and Lithographic offices visited and submitted a report upon the offices of the field parties at Naini Tal and Mussooree, as well as the offices of the Trigonometrical Branch at Dehra, with a view to the more effective preparation of fair copy sheets for reproduction by those processes, and their publication for general use. This officer also took part in a committee convened to consider the unsatisfactory working condition of the large photo-heliograph received from England and lately set up in its new observatory at Dehra.

THE TECHNICAL OFFICES.

39. The great publishing and map-printing offices at Calcutta, and the minor offices of the same class at Dehra, have undertaken a large amount of work for the Foreign and other departments, being ever ready to meet the requirements of the service. Thus, besides the large issues of maps of every class, the ornamental award certificates of the late Calcutta Exhibition have been turned out to the number of three thousand by the Calcutta establishment, with the aid of the heliogravure and collotype processes; and a *fac simile* of an ancient manuscript in the Gurmukhi character of the Punjab has been reproduced by photo-zincography at the Dehra office, after the method adopted with the "Domesday Book" in England: besides many others.

40. The Mathematical Instrument office, which is the repairing shop of delicate instruments, the repository and issuing office of surveying implements for, speaking generally, the whole of India, having obtained a special grant of money has taken in hand on a much extended scale the repairs of the accumulated stock of slightly injured instruments with a view to their re-issue. The saving of expenditure on new instruments indented for from England will, it is expected, prove of importance.

41. The copper-plate Engraving office has continued the engraving of the great series of sheets of the Atlas of India. The probable date of the completion of this work cannot be calculated. Native artists have been trained, and are now regularly engaged on the process.

EXHIBITS AT THE CALCUTTA INTERNATIONAL EXHIBITION OF 1883-84.

42. The resources of the three Branches of the Survey of India were drawn upon with a view to presenting to the public specimens of the maps of the Trigonometrical, Topographical, and Revenue Surveys as reproduced by the photo-zincographic process now in such extensive and increasing use. These were supplemented by other specimens, the products of the Engraving and the Lithographic offices, and included the delicate impressions obtained by the Heliogravure and Collotype processes.

The maps comprised specimens of the cadastral or field-by-field surveys, of the city plans, forest surveys, and topographical delineations of countries within and beyond the boundary of India, of varying scales of the regular survey, down to that of the reconnaissance or route survey of the explorer.

A series of thirteen large maps were specially prepared so as to exhibit the material progress and state of India as regards geology, river basins, irrigation crops, rainfall, languages, religions, density of population, internal trade, missionary stations, telegraphs, railways, and roads. An *alto-relievo* model map of India showing the contour lines at regular intervals was also constructed.

43. A series of pictures of the sun's disc obtained by the agency of the photo-heliograph of 8″ diameter; and a set of diagrams, the resultant of the Tidal Operations which are in progress at the ports of the Indian seas, extending from Aden to British Burma, were laid out: and at the same time the intermediate

processes required for producing a complete map in chromo-lithography, photo-zincography, collotype, and heliogravure, were exhibited; as well as specimens of *fac simile* reproductions of ancient records, vernacular handwritings, and many miscellaneous objects.

44. Instruments in use in the various operations during the last half century were laid out for inspection, including one of the original 36-inch theodolites by Messrs. Troughton and Simms with which have been measured the angles of the principal triangulation of the Great Trigonometrical Survey; the fine zenith sector, one of the latest and most refined efforts of Messrs. Troughton and Simms; closing the series of angle-measurers with the small 3-inch theodolite intended for the use of the native explorers of the trans-frontier.

45. The volumes of the Account of the Operations of the Great Trigonometrical Survey were also exhibited.

46. The Executive Committee of the Exhibition have been pleased to award three gold medals to the department, including the Photographic and Lithographic Offices, as well as a silver medal for solar photographs to the Trigonometrical Branch, and it may be here remarked that the three thousand ornamental award certificates of that Exhibition were the work of the former office.

GENERAL REMARKS.

47. Thus the Survey of India in all its numerous ramifications has been entirely and effectively occupied. The duties falling under its hands have been multifarious, and have reached the full limit of its powers, so that no spare officers whatever have remained to form a reserve against a sudden emergency: the continued reductions of establishment, only lately came to an end after years of absorptions of steps, and the consequent cessation of appointments, have reduced the department to a dangerous ebb of depletion, so that it has been felt sometimes that the work was in excess of the capacity of the workmen. The question of filling the posts of superintending officers of the Photographic and technical offices, and of previous training of such officers, is one that should receive attention.

48. Some innovations have been introduced into the operations of the department during the year.

In all the technical offices thirteen European and Eurasian youths have been entertained as apprentices,—thus following out the principle inaugurated in the Ordnance Department of raising an indigenous staff of skilled workmen, a class hitherto obtained only from England.

A new system of accounts has been introduced into the Mathematical Instrument office, by which great saving of time and labour is effected, combined with simplicity of application.

An adaptation of the Heliogravure process, whereby copper plates are bitten into by chemicals kept under control by photography, and are engraved or etched so as to give a delicate and accurate impression of a map or other object, such as the works of art displayed in the late Calcutta Exhibition, has made great progress, and is being extensively utilized.

A printing machine, worked by hand, for the rapid production of maps, has been introduced into use in the Lithographic office with good results.

In the trans-frontier field detachments a mule equipment has been employed for the carriage of instruments, so as to spare the men, who otherwise would prove on an occasion incapacitated by fatigue, and unfit for their signalling duties.

For the general information of the department, the officers of which are scattered over and beyond the limits of the Empire of India, and are necessarily in a measure precluded from obtaining news of the doings of their brother officers and of the Department in all its branches, a monthly *brochure* entitled "the Survey of India Department Notes" has been established, and issued to all departmental officers on duty in India, to retired officers, and those absent in England, besides to societies and all who desire to receive it. This publication, referring to the year 1884, furnishes a concise history of the department, and a record of all orders for promotions and other subjects for the period named.

PART II.

THE OPERATIONS OF THE SEVERAL SURVEY PARTIES APPERTAINING TO THE THREE BRANCHES OF THE SURVEY OF INDIA.

TRIANGULATION.

COAST, ORISSA AND GANJAM.

(THE SECONDARY TRIANGULATION PARTY.)

Personnel.

Mr. A. D'Souza, Surveyor, 1st grade.
„ C. D. Potter, Assistant Surveyor, 1st grade.

MR. A. D'SOUZA, Surveyor, 1st grade, since promoted into the Senior Department, assumed charge of this party from Mr. J. McGill, Deputy Superintendent, 4th grade, on the 16th October 1883, on the latter taking furlough.

2. The work laid down for the party was the looking up of the old stations of the East Coast Series, extending from Pooree to Balasore, executed in 1858-59 by Major Saxton and Captain DePrée, and building beacons on such of the stations as may be found on the coast, so as to give points of reference at intervals of 5 to 15 miles on the coast for the use of the Marine Survey.

Doubts having been entertained as to the existence of the old stations on the coast, the ground was first reconnoitred, and it was found that, although nearly all these seaward stations had been destroyed by the encroachments of the sea, most of the inland flank stations were recovered. Those found on the coast were utilized, and beacons of the usual dimensions were built over them; but where stations had been destroyed, a new series of triangles was executed, based on the sides of the old triangulation, and the positions of the beacons which were constructed were thereby determined.

3. The beacons and buoys of False Point harbour and the Dhamra river were accurately fixed by triangulation, as well as all the prominent objects on the coast that could be used as landmarks for navigation along the coast.

4. The stations of the old triangulation which were found, besides those which were used for beacons, were repaired, and ordinary rectangular covering pillars were built over them, these latter being also covered with mounds of earth as a further protection. The beacons were generally built of masonry, obelisk shape, 15 feet high; but a few of them were constructed of wooden spars from 12 to 15 feet in height, embedded in masonry pillars, and topped with crosses or diamonds painted of various colours.

5. The country through which the work was carried on is unhealthy and intricate, and presents serious obstacles to rapid progress. The greater portion of it is jungly swamp, intersected by numerous rivers and tidal creeks. Boats had to be used for the transport of the party, almost throughout the season; provisions had to be brought from great distances; and building materials were only procurable from the principal towns, such as Cuttack, Pooree and Balasore, and had to be carried over distances, often exceeding a hundred miles.

6. The field season extended from 25th October 1883 to the middle of April 1884.

During the ensuing season the triangulation will be extended southwards along the Madras coast, in continuation of completed work.*

*Mr. D'Souza reports favourably of the work performed by Mr. Potter.

TOPOGRAPHY.

ALIGARH AND ETAH DISTRICTS, NORTH-WEST PROVINCES.

(No. 3 PARTY, REVENUE BRANCH.)

7. This party, during the field season, has been under the charge of Mr. J. O. N. James and Major E. H. Steel. On Major Steel's return from furlough, he relieved Mr. James on 27th October 1883, and held charge till 26th January 1884, during Mr. James' absence on leave. Mr. James re-assumed charge on the latter date, and the party continued under his superintendence until 6th August 1884, the date of his retirement from the service, on attaining the age of 55 years. Major Steel, who in the meantime had been superintending the operations of three small detached parties, again received charge of this party in addition to his other duties.

Personnel.

Mr. J. O. N. James, Officiating Deputy Superintendent, 2nd grade, in charge from 1st to 26th October 1883 and from 27th January to 6th August 1884.
Major E. H. Steel, Deputy Superintendent, 4th grade, in charge from 27th October 1883 to 26th January 1884, and from 7th August 1884.
Mr. C. W. Wilson, Assistant Surveyor, 1st grade.
„ C. W. F. Seyers, ditto, 1st do.
„ F. W. Moore, ditto, 3rd do. from 13th December 1883.
„ T. W. Babonau, Jr., Assistant Surveyor, 3rd grade, from 15th January 1884.
37 Sub-surveyors, computers, &c.

8. The field operations commenced on 10th October 1883, and were continued until 15th April, when the party returned to its recess quarters in Mussoorie.

9. The same system of survey was continued as in previous seasons, the principal work being a 2-inch topographical survey in districts Aligarh and Etah. The riparian tract on both sides of the Ganges, conterminous with the above operation, has been surveyed on the 4-inch scale. In the 2-inch area the village boundaries have been obtained by transfer from maps of the Settlement Department, a connection therewith having been provided by fixing the trijunctions of the boundaries by means of traverses which were run between trigonometrical stations. In the riverain area the village boundaries have been re-surveyed.

10. The survey has extended down to the parallel of latitude 27° 30′, and the separate areas on the different scales in the districts that were under survey are shown in the following table:—

Districts.	On 2-inch scale.	On 4-inch scale.	Total.
	Sq. miles.	Sq. miles.	Sq. miles.
Aligarh	715·64	.....	715·64
Etah	785·00	49·92	834·92
Mainpuri	2·46	.....	.....
Budaon	.....	48·17	48·17
Total area ...	1,503·10	98·09	1,598·73

The civil station and city of Etah, covering an area of 3·6 miles, has also been surveyed on the 6-inch scale; and the survey of the town of Kasganj, now fast growing in importance, was undertaken for and at the expense of the municipality on the scale of 20-inches to a mile. In addition to the above, preparatory skeleton traversing has been extended over an area of 307 miles in advance of the detail survey.

11. The topography, which was surveyed as minutely as the scale would admit, has been tested by 377 linear miles of check survey. The main traverses have been run between trigonometrical stations, and the chain measurements made to accord with the triangulated distances. 39 azimuths were observed for the verification of the angular work: the correction required in both classes was small, and the results satisfactory.

12. The permanent demarcation has been carried out by means of pottery cylinders embedded at all theodolite stations. An improved description of cylinder was used in district Etah, which was slightly smaller, but thicker and better baked and made at a greatly reduced cost.

INDEX TO THE

N. W. PROVINCES SURVEY.

No. 3 REV. PARTY.

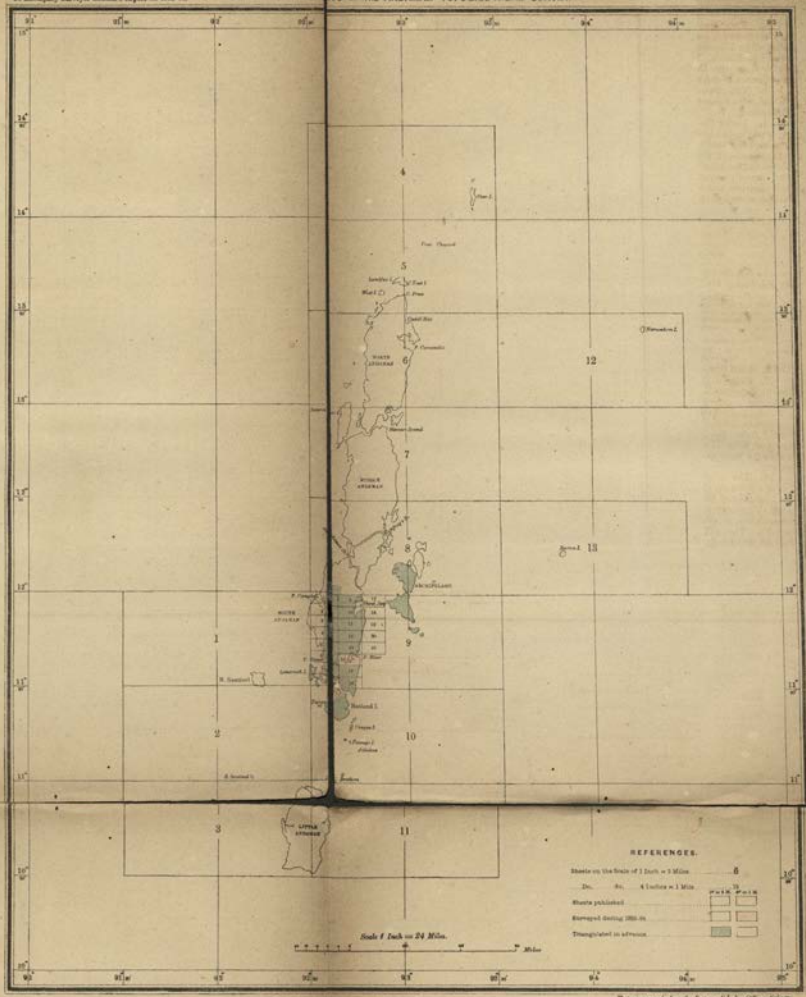
Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S.C., Surveyor General of India.

Survey of India Offices, Calcutta, March 1885

To accompany Surveyor General's Report for 1883-84.

INDEX TO THE SHEETS OF THE ANDAMAN TOPOGRAPHICAL SURVEY.



Published under the direction of Colonel G. C. De Pyre, S. C., Surveyor General of India.
Survey of India Offices, Calcutta, February
1885.

Photo-zincographed at the Survey of India Offices, Calcutta.

13. Two sets of fair maps of the season's outturn on the 2-inch scale have been drawn, comprising 30 sheets. Of these sheets, one set has been prepared for reproduction on the same scale, and the second set for reduction to the 1-inch scale. Traces of the Gangetic riparian tract have been made and furnished to the Collectors of the districts operated in. A reduction of the season's area to the scale of the atlas of India has also been prepared.

14. The office of this party was inspected in September by the Surveyor-General, who commends the able management of the Deputy Superintendent, Major Steel.

15. Under the orders of the Government of India, the continuance of the topographical survey of the remaining districts in the North-West Provinces has been suspended under the consideration that the existing revenue maps, in spite of their imperfections, will answer the requirements of the civil administration for revenue purposes, and that surveys in other provinces are more urgently required. This party has therefore been withdrawn from the Etah district, and will be employed in the ensuing season on the boundary traverse survey of the Ajmere-Merwara district.*

ANDAMAN SURVEY.

(No. 4 Topographical Party.)

16. On the representation of the Officiating Superintendent of Port Blair and the Nicobars to the Secretary to the Government of India, it was urged that the want of a suitable map of South Andaman Island was much felt by the Settlement Officers, in dealing with matters connected with land revenue, forest department, and other local works, whereupon the Government of India was pleased to sanction the survey of that island by their No. 349—117-6S, dated 9th August 1883.

Personnel.

Captain J. R. Hobday, Officiating Deputy Superintendent, 4th grade, in charge.
Mr. J. Keating, Assistant Surveyor, 2nd grade.
„ D. Campbell, ditto, 2nd do.

Sub-Surveyors.

Faida Ali, | Niaz Hosein, and one other.

17. Captain J. R. Hobday, who was in temporary charge of No. 11, South Deccan Topographical Party at Poona, was ordered to head-quarters, Calcutta, to organize a survey party to undertake the survey of the Andaman Islands, and embarked for the field of operations on the 24th November 1883.

Messrs. Keating, Campbell and sub-surveyor Faida Ali were transferred from No. 6, North-East Frontier Topographical Party, and sub-surveyor Niaz Hosein from the Burma Topographical Party. No additions or changes were made in the strength of the party during the season under review.

18. The only available datum on which to base the survey was the position of a point on Chatham Island in the harbour of Port Blair, the latitude and longitude of which had been determined astronomically in 1863 by the Great Trigonometrical Survey, so that in order to undertake a systematic triangulation it was necessary to measure a base line and determine an initial azimuth. The site of the base line was chosen and carefully levelled and drained, and finally measured with the standard iron bar on a raised causeway which served as a rifle range, situated on a piece of reclaimed land in Navy Bay, within the harbour of Port Blair. The result of the measurements was as follows:—

From A to B	...	...	...	...	2,881′ 4″·81
From B to A	...	...	...	...	2,881′ 4″·64
			Difference	...	0″·17

* Major Steel reports that Mr. C. W. Wilson is an excellent surveyor, and that he always carries out his duties in an efficient manner; that Mr. C. W. Seyers has worked satisfactorily, both in the field and during the recess. Messrs. F. W. Moore and T. W. Babonau, Jr., who have lately joined the department, are both favourably reported on, and promise to become good surveyors.

The native surveyors, &c., have given satisfaction, and the following are specially commended:—Baboo Bhagobati Charana Chakravarti, writer and accountant; Kadar Nath, computer; Surfraz Khan and Didar Bux, draftsmen; and sub-surveyor Nejabut Hosain.

19. Starting from the newly-measured base line, Captain Hobday commenced the triangulation, aided by Messrs. Keating and Campbell, allotting to the former the extension into the southern district, whilst the latter extended it to the northward, the harbour of Port Blair dividing the two districts. The triangulation in the immediate vicinity of Port Blair was computed and the points plotted by distances and an approximate azimuth, thus enabling the detail survey to be commenced by sub-surveyor Faida Ali by the end of January, and about the middle of the same month sub-surveyor Niaz Hossein was ordered to run traverses along the tracks cut through the forest in the southern district. On Messrs. Keating and Campbell completing the triangulation allotted to them about the middle of April, they were deputed to plane-table in order to finish the detail survey of sheet No. 14, of which the sub-surveyors had already completed the greater portion. The result of the season's outturn is the map of Barren Island and the Island of Narcondam on the scale of 8 inches=1 mile, and sheet No. 14 on the scale of 4 inches=1 mile, for publication.

20. In consultation with the Chief Commissioner of the Andamans and Nicobars it has been decided that the ½-inch scale is to be adopted for the general survey of the Andamans, and that certain portions of the South Andamans between the parallels of 11° 30″ and 11° 48′ 45″ shall be surveyed on the scale of 4 inches=1 mile. This, it is thought, will give a sufficient area for the development of the settlement for some time to come, whilst it is considered that the smaller scale will suffice for a reliable geographical map, showing an accurate delineation of the coast line and the principal hill ranges and creeks of these islands. To carry out this scheme, a steamer has been placed at the disposal of the Survey party during the coming field season. Officers from the Geological Survey and Forest Department will also accompany the Survey party to ascertain the resources of these islands.

21. The system adopted to show the hill features on the 4-inch maps is a modified method of contouring, the contours being obtained with the water-level along the ridges and spurs and the intermediate spaces sketched in by eye, each contour showing a vertical interval of 25 feet apart. The system of water-levels is a simple and speedy one, and causes very little delay to the surveyor engaged on the detail survey.

22. During the coming field season the detail survey of sheets 12, 13, 15, 16 and 20 on the scale of 4 inches=1 mile, and the triangulation and detail survey on the ½-inch scale of the whole group, with the exception of the Little Andaman (our relations with the inhabitants of this island not being sufficiently amicable) will, if possible, be taken up.*

ASSAM AND NORTH-EAST FRONTIER SURVEY.

(No. 6 Topographical Party.)

23. This party, as stated in last year's report, was to have been employed in surveying the Noa Dihing valley, the hitherto unexplored portions of the Patkai range on the extreme north-eastern frontier of Assam, but owing to the Aka raid on Balipara, this work was postponed, and the survey party, in accordance with the wishes of the Chief Commissioner of Assam, was ordered to accompany the military force which was sent into the hills to recover certain captive British subjects.

Personnel.

Lieutenant-Colonel R. G. Woodthorpe, R.E., Officiating Deputy Superintendent, 4th grade, in charge.
Mr. M. J. Ogle, Surveyor, 3rd grade.
„ A. Ewing, Assistant Surveyor, 3rd grade

Sub-Surveyors.

Shah Nasiruddin. | Mahomed Hussain.

24. Lieutenant-Colonel Woodthorpe having placed 150 of his coolies at the disposal of the military authorities, an advance force under the command of Major Beresford left Dirju Mukh on the 17th December.

25. Whilst the expedition was being organized at Dirju Mukh, preliminary survey operations were carried on at three stations of the great triangulation—Singri, Sildubi and Kamakia—and two new peaks, Guinuja and Sonai, were cleared and observed from, giving a base for starting the detail sketching, which was continued along the whole line of march of the expedition, embracing

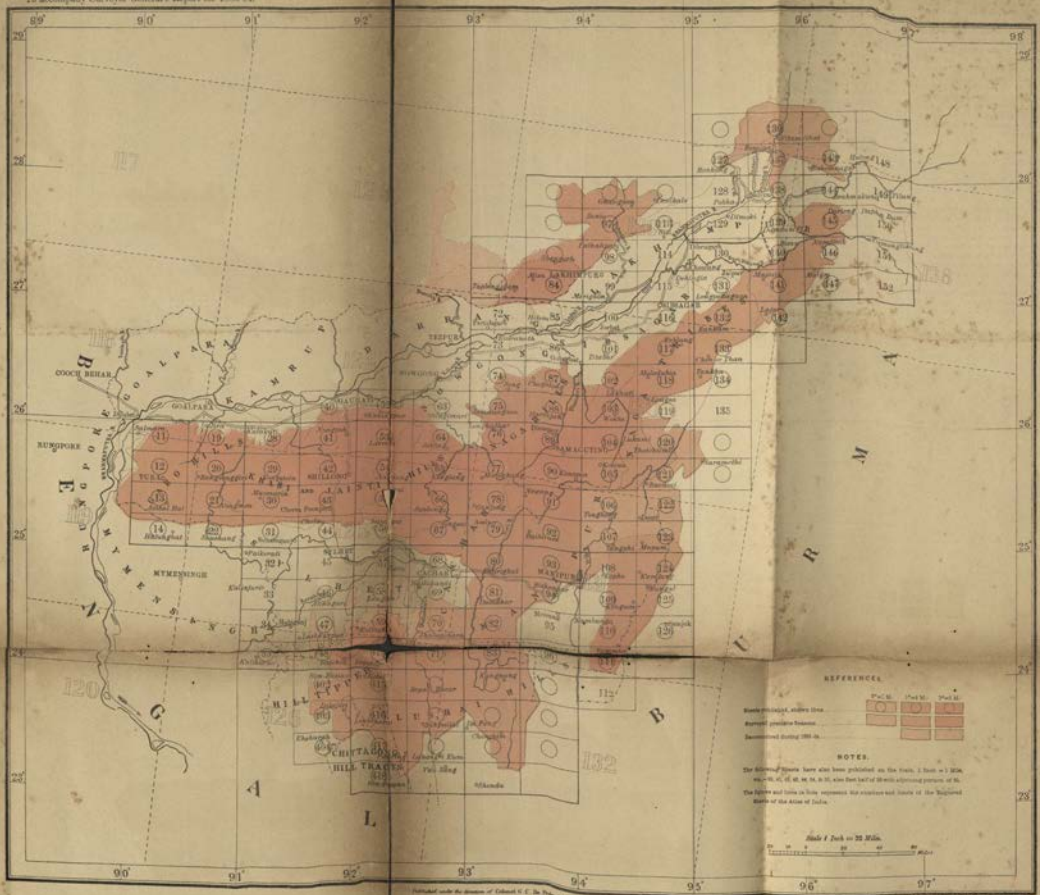
* Captain Hobday reports as follows regarding the services of his assistants and sub-surveyors:—
"The assistants and sub-surveyors worked zealously and well under peculiarly novel and trying circumstances in the field, and their duties in recess have been carried out with commendable assiduity."

No. 6 PARTY.

INDEX TO THE SHEETS OF THE GARO, KHASI & NAGA HILLS & N.E. FRONTIER TOPOGRAPHICAL SURVEY

To accompany Surveyor General's Report for 1883-84.

On the Scales of 1 Inch = 1 Mile, ½ Inch = 1 Mile, and ¼ Inch = 1 Mile.



Published under the direction of Colonel G. C. De Vaux, R.E., Surveyor General of India.

Survey of India Offices, Calcutta, April 1885.

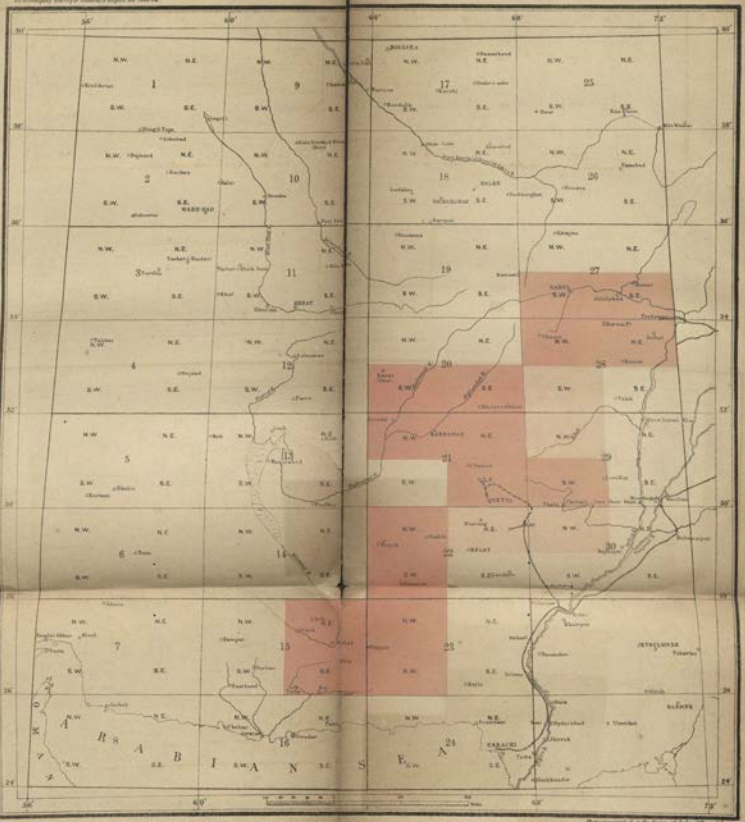
Photo-zincographed at the Survey of India Offices, Calcutta.

Survey of India Department.

INDEX TO THE SHEET MAPS OF THE NORTH WESTERN TRANS-FRONTIER

On the Scales of 1 Inch to [illegible] Miles, 8 Miles, 4 Miles, and 2 Miles.

To accompany Surveyor General's Report for 1893-94.



Published under the direction of Colonel G. C. De Vere, R.E., Surveyor General of India.

Survey of India Offices, Calcutta, April 1895.

Photozincographed at the Survey of India Offices, Calcutta.

NOTE.

Sheets on the Scale of 1 Inch to 8 Miles are numbered No. 1, No. 2, &c.

A Sheet on the Scale of 1 Inch to 16 Miles will consist of 4 of the Sheets shown on the Index; they are indicated by slightly thicker lines. They will be distinct from—Sheet No. 1, 2, 3 and 10.

A Sheet on the Scale of 1 Inch to 4 Miles will consist of a one-fourth part of the Sheet shown on the Index, and will be entitled Sheet No. 1 N.W., No. 2 N.E., &c. (Vide Diagram).

A Sheet on the Scale of 1 Inch to 2 Miles will consist of a one-sixteenth part of the Sheet shown on the Index, and one-fourth part of the quarter-inch sheet, and will be entitled Sheet No. 1 $\frac{1}{4}$ N.W., 2 $\frac{1}{4}$ N.E., &c. (Vide Diagram).

1	2	1	2
NW		NE	
3	4	3	4
	2		
1	2	1	2
SW		SE	
3	4	3	4

REFERENCES.

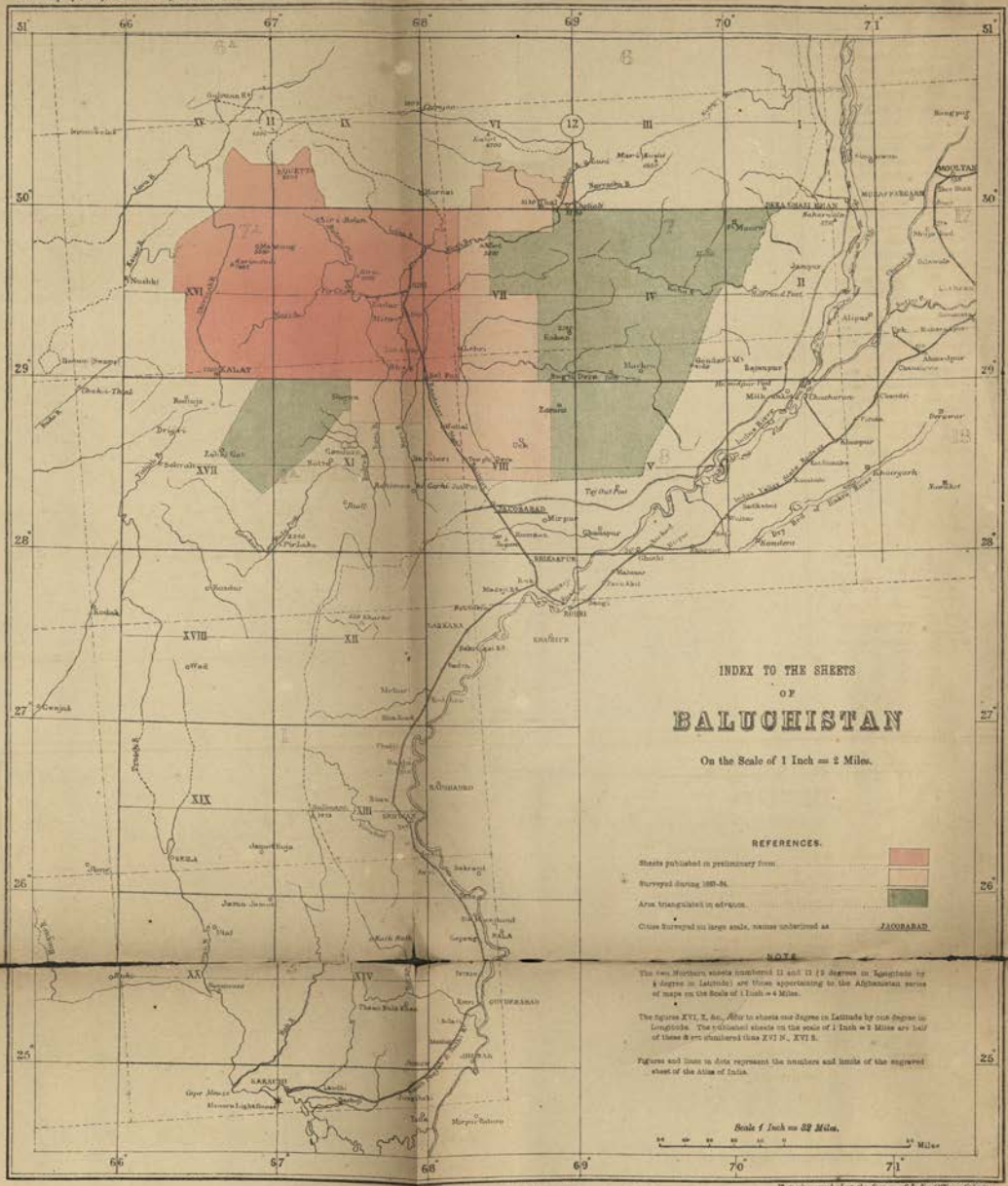
[illegible]	[illegible]
[illegible]	[illegible]

REFERENCE.

Indicates sheets already published.

" " in progress.

To accompany Surveyor General's Report for 1883-84.


INDEX TO THE SHEETS
OF
BALUCHISTAN
On the Scale of 1 Inch = 2 Miles.
REFERENCES.
Sheets published in preliminary form
Surveyed during 1883-84.
Area triangulated in advance.
Cities Surveyed on large scale, names underlined as JACOBABAD
NOTE.
The two Northern sheets numbered II and 12 (2 degrees in Longitude by 1 degree in Latitude) are those appertaining to the Afghanistan series of maps on the Scale of 1 Inch = 4 Miles.
The figures XVI, X, &c., XIII to sheets one degree in Latitude by one degree in Longitude. The rectangular sheets on the scale of 1 Inch = 2 Miles are half of these & are numbered thus XVI N., XVI S.
Figures and lines in dots represent the numbers and limits of the engraved sheet of the Atlas of India.
Scale 1 Inch = 32 Miles.
Miles
KALAT
KHANGARH
BRIKARTUN
JACOBABAD
SUKHASAR
GHUFFARABAD
KARACHI
MOOLTAN
MUZAFFERGARH
DERA GHAZI KHAN
SHIKARPUR
SUKKUR
KHAIRPUR
JHANGARA
Mirpur Sakoro
Oyster Rocks
Manora Lighthouse

Published under the direction of Colonel G. C. De Pree, R.E., Surveyor General of India.
Survey of India Office, Calcutta, February 1885

Photozincographed at the Survey of India Office, Calcutta

oth banks of the Dirju and Bhoroli rivers, as far as the Tenga river; beyond 's a high ridge to the north of the villages of Mehdi and Labi (two Aka iefs) was visited, from whence a widely extended view of the country ards the lofty snowy peaks of Tibet was obtained and sketched, but itary considerations did not allow of the surveyors visiting much of the country, for on the 29th January the whole expedition commenced its urn journey *viâ* Dirju Mukh to Balipara.

26. The work in the Aka Hills being now at an end, it was decided in sultation with the Chief Commissioner that a portion of the survey party uld be employed for the remainder of the season on an exploring expedition he Daphla country, in company with Mr. Penny, an energetic tea-planter, o had had much experience in dealing with these wild and independent es. Some valuable information was obtained by Lieutenant-Colonel Wood- rpe during this expedition to the Daphla hills, regarding the existence the Kameng river, a large branch of the Bhoroli. At the same time etachment under Mr. Ewing was sent to fill in a blank in the Bhutan hills. e result of the season's operations in the Aka and Daphla hills, including the rtion of country mapped in the Bhutan hills, is 1,934 square miles of detail urvey on the scale of 1 inch=4 miles, in addition to 622 square miles on the scale of 1 inch=2 miles and 143 linear miles of route and river survey done by native explorers within our own borders.

27. The Aka and Daphla work has been fair drawn and incorporated in one map, showing also the work previously done on these hills, all on the scale of 1 inch=4 miles. The work done on the scale of 1 inch=2 miles has also been incorporated with the work previously done on this scale, and reproduced in two sheets. In addition to this, three fair maps of South Sylhet have been completed and sent for publication.

28. The health of the party was unfortunately bad; cholera carried off a large number of the followers, and many more died, or were incapacitated from pneumonia, fever, and other diseases, due to exposure and hard work.

29. The party, as provided for in the programme of operations of the Survey of India, will be employed during the ensuing field season on the survey of the country beyond the Lakhimpur inner line and the unexplored portions of the Patkai range, or in prosecution of the programme of the last season, abruptly abandoned on the occurrence of the Aka raid.*

BALUCHISTAN SURVEY.

(No. 3 Topographical Party.)

30. During the year under review the charge of this party was held by several officers. Major Holdich, R.E., who was in charge at the commencement of the field season, went on furlough on the 6th March 1884, when the charge devolved on Mr. Claudius, Surveyor, 4th grade, who held it until the 28th April, when he was relieved by Lieutenant the Hon'ble M. G. Talbot. This officer remained in charge until the 18th August, when he joined the Afghan Boundary Commission, and made over the party to Lieutenant Wahab, R.E.: on this officer being transferred to the Military Department for service in the Zhob expedition, the charge again devolved on Mr. Claudius, who held it from the 1st September up to the date of this report.

Personnel.

Major T. H. Holdich, R.E., in charge up to 5th March 1884.
Lt. the Hon'ble M. G. Talbot, R.E., in charge from 28th April 1884 up to 18th August 1884.
Lt. R. A. Wahab, R.E., in charge from 19th to 31st August 1884.
Mr. T. E. M. Claudius, Surveyor, 4th grade, in temporary charge.
Mr. J. T. U. Coxen, Surveyor, 4th grade, from 23rd December 1883.
Mr. A. Kitchen, Assistant Surveyor, 1st grade.
„ G. R. Copping, ditto, 2nd do.

Sub-Surveyors.

Abdul Rasul. | Barkat Ali.
Kadur Sharif.

13. During the season under review, this party was divided into three sections, the one under Major Holdich, R.E., was employed on the Takht-i-Suleman expedition, the second under Lieutenant Talbot, R.E., accompanied Sir Robert Sandeman's Mission in South-West Baluchistan, whilst the third under

* Lieutenant-Colonel Woodthorpe speaks in the highest terms of the services of Mr. Ogle, who held charge of the party during his absence on privilege leave. Mr. Ewing has also shown much determination and energy. The sub-surveyors Shah Nasiruddin and Mahomed Hussain are both reported as having done well.

Mr. Claudius took up the regular detail survey, and was further strengthened after the Takht-i-Suleman expedition by the arrival of Mr. Coxen and su surveyor Hira Sing.

32. The programme for the season's work, which had been decided on Major Holdich, had to be considerably modified on submission to the Politi officers. Hence Mr. Claudius, after consultation with Mr. Bruce, C.I.E., adop other measures whereby the risk of operating in that unsettled country minimized, but the field of operations was curtailed, and the detail survey were unable to take up the plane-tabling of a large portion of the previo triangulated ground.

33. The triangulation carried on during the season covered an area 6,100 square miles: it consisted of two series, one undertaken by Mr. Coppi starting from the base Dragal to Siah Koh in the south-east portion of Deg Sheet No. IV, covers the whole of Sheet No. V, and extending westward, conne on to a series previously carried east from the Baluchistan Series.

Later on in the season Mr. Coxen carried a second series westw from the side Makhan Baila to Manju of the Baluchistan Series, closing a triangulation carried over the highlands of Kalat in 1882-83.

Mr. Claudius triangulated about 2,100 square miles, the greater portio of which consisted of the Kachi desert. Mr. Copping was employed exclusively on triangulation throughout the field season: starting from the outpost of Harrand on the Dera Ghazi Khan frontier he covered an area of 3,500 square miles, fixing 17 new stations and 76 intersected points, comprising the whole of the Bagti Dera territory which extends over portions of Degree Sheets IV, V, VI and VIII. In addition to the above, Mr. Coxen also took up a portion of the triangulation of the Kachi desert covering an area of 500 square miles, aggregating in all an outturn of 6,100 square miles of triangulation for the season.

34. The season's topography on the ½-inch scale was carried on in the Thal Chotiali territory and the Kachi desert, which was for the most part flat, easy country: many difficulties, however, had to be overcome and the large outturn of 4,840 square miles in the face of these, cannot but be considered most creditable to all concerned.

35. Two most interesting reports on the work of the other sections of this party will be found in the appendix—one by Major T. H. Holdich, R.E., of the Takht-i-Suleman expedition, and the other by Lieutenant the Hon'ble M. G. Talbot, R.E., of the mission in South-West Baluchistan under Sir R. Sandeman.

36. The programme for the ensuing field season is to take up the detail survey of half Degree Sheet No. IX south, which includes the whole of the Harnai route. In addition, half Degree Sheets VII north and south and VIII north will be completed, and No. V north will be taken in hand. The triangulation of Degree Sheet XI will, if possible, be completed and that of Sheet No. XVI in the neighbourhood of Nushki commenced.*

CUTCH TOPOGRAPHICAL SURVEY.

37. The operations of this survey were carried on as before under Lieutenant-Colonel Pullan. The outturn comprises 2,154 square miles of topography on the 2-inch scale, 1,086 square miles on the ½-inch scale, an area of 2,100 square miles triangulated in advance, comprised in sheets 31, 33, 34 and 35, and 203 linear miles of traversing, covering 450 square miles of the Rann: 467 linear miles of traversing were also run to check the season's topography.

Personnel.

Lieutenant-Colonel A. Pullan, s.c., Deputy Superintendent, 3rd grade, in charge.		
Mr. N. C. Gwynne,	Surveyor,	4th grade.
„ W. A. Fielding,	Assistant Surveyor,	1st do.
„ G. T. Hall,	ditto,	1st do.
„ P. F. Prunty,	ditto,	2nd do.

Sub-Surveyors.

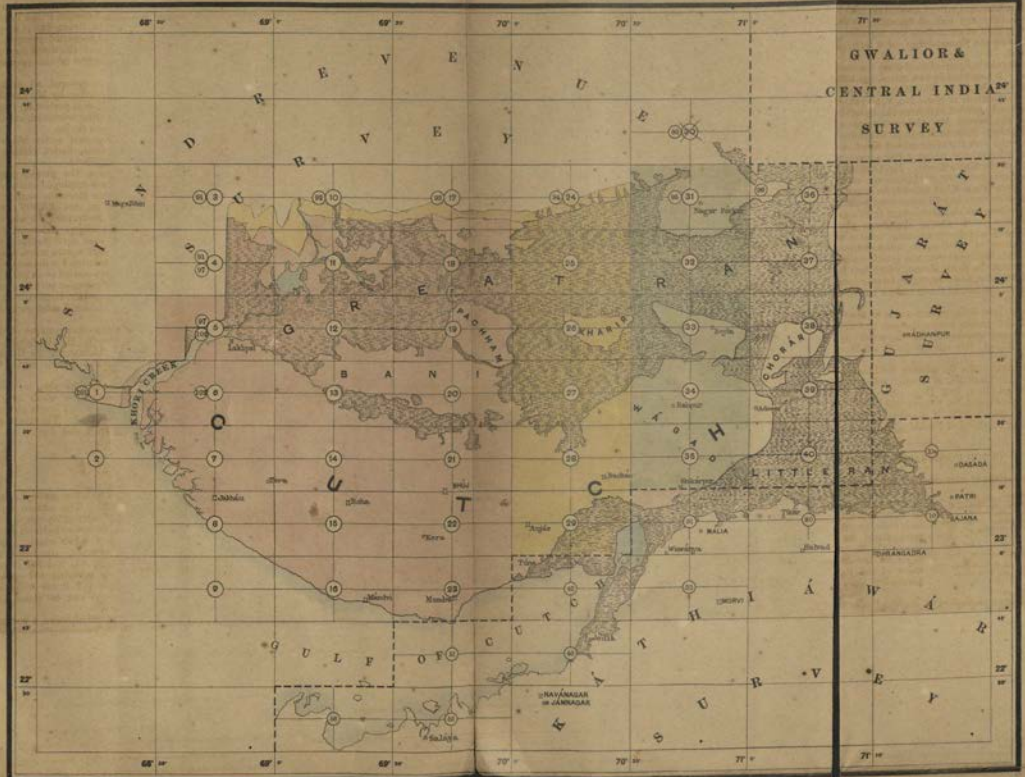
V. R. Gadbole	G. R. Bhopatkar,
N. D. Patwardhan,	and seven others.

38. The sheets topographically surveyed were 25 to 29 inclusive, a portion of 24, and a margin covering altogether about 300 square miles, along the northern

* Lieutenant the Hon'ble M. G. Talbot, under whose charge the work of this party was carried on during the recess, reports in the highest terms of Mr. Claudius' administration during the time he was in temporary charge. Messrs. Kitchen and Copping are also spoken of as having given entire satisfaction.

TRIGONOMETRICAL BRANCH, SURVEY OF INDIA.

INDEX CHART OF THE CUTCH TOPOGRAPHICAL SURVEY.



The numerals (1) (2) (3) &c., indicate the sheets on the scale of 1 inch to the mile.

The smaller numerals as (22) or (14) indicate the sheets of adjoining surveys.

The originals at the 1-inch sheets are drawn on the 2-inch scale and are divided into 4 sections, known as **N.E., N.W., S.E.,** and **S.W.**

Sheets 2,4,10,11,17,18,24, and 25, have been surveyed on the scale of ½ inch = 1 mile.

Published under the direction of Colonel G. C. De Prée, S.C., *Surveyor General of India.*

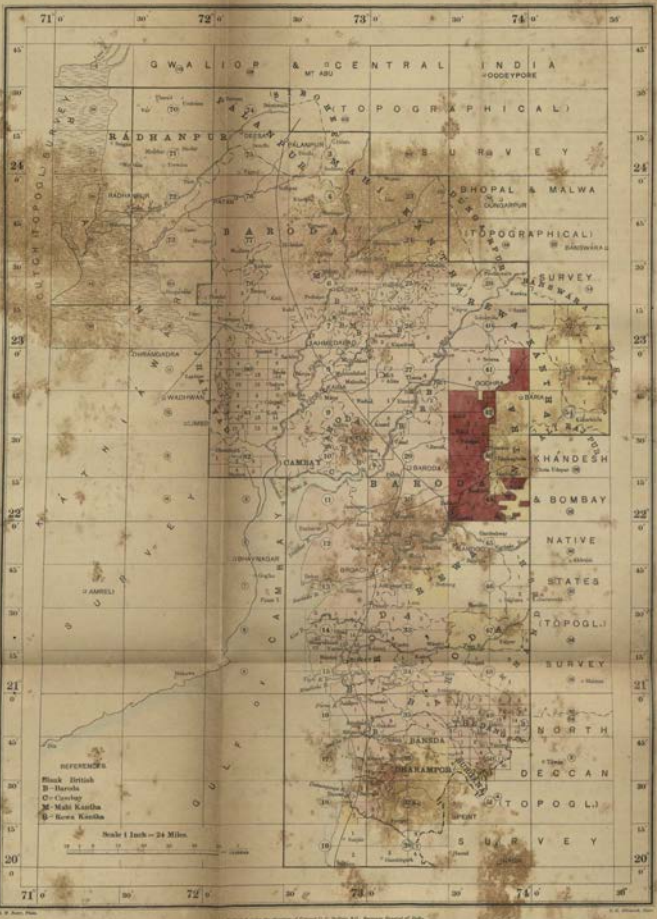
Scale 1 inch = 10 miles 10 5 0 10 20 30 40 50 1/1140160

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun, December 1908.

Dessins country Topographically Surveyed up to 1842-43
" " " " " 1867-68
" " Triangulated and Traversed in advance

SURVEY OF INDIA.

INDEX CHART of the GUJARÁT SURVEY.



boundary of the Rann, previously surveyed in sheets 3, 10, and 17, to effect a proper junction with the survey of Sind. Of the surveyed area, about 1,800 square miles were featureless Rann, but about 700 square miles of this were surveyed on the 2-inch scale for convenience of squaring off the field sections containing country necessarily surveyed on that scale. In sheet 25 the only feature besides the salt Rann is a bare basalt rock known as Meruda Bet (Bet meaning island), rising 55 feet above the plain, affording a shady halting place on the march between Sind and Cutch. Sheet 26 contains the rocky and wooded island, Kharir Bet, with an area of about 140 square miles, the largest village having a population of 555. The portion of Cutch proper falling in sheets 27, 28, and 29 contains the towns of Chaubári, Bhachau, and Anjár. The latter is the most ancient in Cutch, and was at one time the seat of the British Residency and a military station, and has at present a population of 12,557.

In the centre of this area the ground is undulating and flecked by ranges of basalt, and to the south the country is some of the most fertile in Cutch. No river of importance crosses the surveyed area, but four miles south-south-east of Anjár is the lake of Shinaya, upwards of four miles in circumference.

39. The area triangulated and traversed in advance comprises sheets 31 to 35, inclusive.

40. There is a large increase in the area of topography over that of the previous season, owing to the large proportion of the Rann. The area triangulated is much the same as in the previous season.

41. There are no arrears of mapping, but this party is preparing second editions of many of the Kattywar maps, the work of which is still in progress. Sheets 6 and 9 have been entirely redrawn, and the necessary corrections and additions have been made to eleven sheets during the past recess. The necessity for these second editions arises from the sheets having been published before the boundaries of the petty States, which are very intricate, had been fully demarcated; and advantage has been taken of the opportunity to introduce new roads and railways, making the maps complete up to date in every respect.

42. It is proposed that, during the ensuing field season, the large scale survey of the town, cantonment and fort of Bhuj be executed on 12 inches to 1 mile, that the triangulation of sheets Nos. 36, 37, 38, 39 and 40 be undertaken, and the topography of sheets Nos. 31, 32, 33, 34 and 35 be surveyed.*

GUZERAT TOPOGRAPHICAL SURVEY.

43. The operations of this party have consisted of the ordinary topographical survey of Native States executed on the 2-inch scale, for publication on the 1-inch scale, and the survey of the Panch Mahals on the 4-inch scale, including village and forest boundaries.

Personnel.

Colonel C. T. Haig, R.E.,	Deputy Superintendent, 1st grade, in charge till 13th March 1884.	
Lieutenant-Colonel W. F. Badgley, S.C.,	Deputy Superintendent, 3rd grade, in charge from 24th March 1884.	
Lieutenant G. B. Hodgson, S.C.,	Assistant Superintendent, 2nd grade.	
Mr. A. D. L. Christie,	Surveyor, 3rd grade.	
„ C. H. McA. Fee,	ditto,	4th do.
„ C. Tapsell,	Assistant	ditto, 1st do.
„ S. F. Norman,	ditto	ditto, 2nd do.
„ C. A Norman,	ditto	ditto, 2nd do.
„ A. George,	ditto	ditto, 3rd do.

Sub-Surveyors.

Gopal Vishnu.	Govind Gopal,
Bhan Govind,	and 27 others.

44. The topographical operations on the 4-inch scale completed the survey of the Godhra, Kálol, and Hálol talukas of the Panch Mahals. The work on the 2-inch scale completed the topography of the foreign territory in sheet 41 and in the western halves of sheets 42 and 43, with a small projection into the eastern half of sheet 42 and about three-quarters of sheet 44.

45. In sheet 43 are the hill of Páwágarh and the old city of Champáner, now mostly in ruins, which together cover an area of about 4 square miles. This being a place of great historical and archæological importance, abounding with Jain and Hindu temples and Muhammadan fortifications and buildings in various stages of ruin and decay, great care was taken to fill in every detail of which the scale was capable; and as the features of the hill are precipitous

*Colonel Pullan reports favourably on the work performed by all his assistants.

on three sides, and the summit 2,300 feet above the base, its survey on the 4-inch scale was no ordinary undertaking. Partly to this, partly to increased density of forest, particularly in the Hálol Mahál where the underwood was entwined with the creeper *kawánch* (cow-itch), and partly to sickness in the more densely forest-clad parts, the outturn of topography compares unfavourably with that of the previous season if reference be made only to the areas. On the 4-inch scale, the area being 452·4 square miles, and on the 2-inch scale 710·7 square miles, against 602·6 and 729·1 square miles respectively in the previous season. The water-level was employed as before over all suitable ground on the 4-inch scale.

46. The operations of the past season bring up the total area topographically surveyed in Guzerat to 18,191 square miles, leaving about 12,350 square miles to complete the province. An area of 2,199 square miles was prepared in advance by triangulation and traversing, for final survey, comprising sheets 47, 52, 53 and 54, which, added to the balance still unsurveyed, gives a total of about 4,140 square miles ready for topography.

47. The mapping stated in last year's report to be considerably in arrears is now nearly all worked off, and the party has practically only current work to cope with.

48. The survey will be carried on as hitherto during the coming field season, and no special remarks are necessary.*

MALWA SURVEY.

(No. 2 Topographical Party.)

49. This party resumed work in the Central India Agency in November 1883, under the charge of Major T. T. Carter, R. E. On 5th August 1884 this officer proceeded on privilege leave, being relieved of the charge of the party by Mr. W. H. Patterson, Assistant Superintendent of Survey.

Personnel.

Major T. T. Carter, R.E., Deputy Superintendent, 1st grade, in charge.		
Mr. J. A. Barker, Assistant Surveyor,		1st grade.
„ G. Vanderbeck,	ditto,	1st do.
„ C George,	ditto,	2nd do.

Sub-Surveyors.

Sheik Omer,	Hyder Ali,
Mr. F. Rozario,	and six others.

50. The season's operations lie between the parallels of $\frac{23° 15'}{24° 00'}$ north latitude and the meridians of $\frac{73° 30'}{74° 30'}$ east longitude, and include portions of Banswara, Oodeypore and Dungarpur, Native States; also a small area of the Mahikanta and Rewakanta Agencies of the Bombay Presidency. The out-turn of work during the field season was the triangulation of 1,390 square miles in Standard Sheets Nos. 58 and 59, and the detail survey on the 1-inch scale of 1,587 square miles in Standard Sheets Nos. 50, 52 and 54. In addition to this, the triangulation and traversing for the large scale survey of the Dungarpur city and Kherwara cantonment were completed.

51. The triangulation was executed by Mr. Vanderbeck with a 10-inch theodolite, and is based on the Oodeypore Series of the Great Trigonometrical Survey, and was connected on to the triangulation executed by the Guzerat Survey on the west and the Gwalior and Central India Survey on the north, with a very satisfactory result. The triangulation stations have all been marked by the usual circle and dots on stones, sunk flush with the ground. The country triangulated is for the most part intricate, hilly, and covered with dense jungle.

52. The country plane-tabled on the scale of 1 inch=1 mile is drained by the Mahi river, which runs in a south-westerly direction through sheets Nos. 50, 52 and 54, forming the boundary between the Banswara and Dungarpur Native States, the hills being densely wooded, and the valleys open and well cultivated, and containing some large villages. The general features of the country present great difficulties to the detail surveyor, the ground being intricate and much cut up by small streams and innumerable little hillocks, so situated that considerable care and patience have to be exercised in surveying them correctly.

---

* Colonels Haig and Badgley report favourably of all their assistants, special mention being made of Mr. S. F. Norman, to whom was entrusted the survey and mapping of Páwágarh and Chámpáner.

No. 2 PARTY.

INDEX TO THE SHEETS OF THE BHOPAL & MALWA TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch = 1 Mile.

To accompany Surveyor General's Report, 1882-84

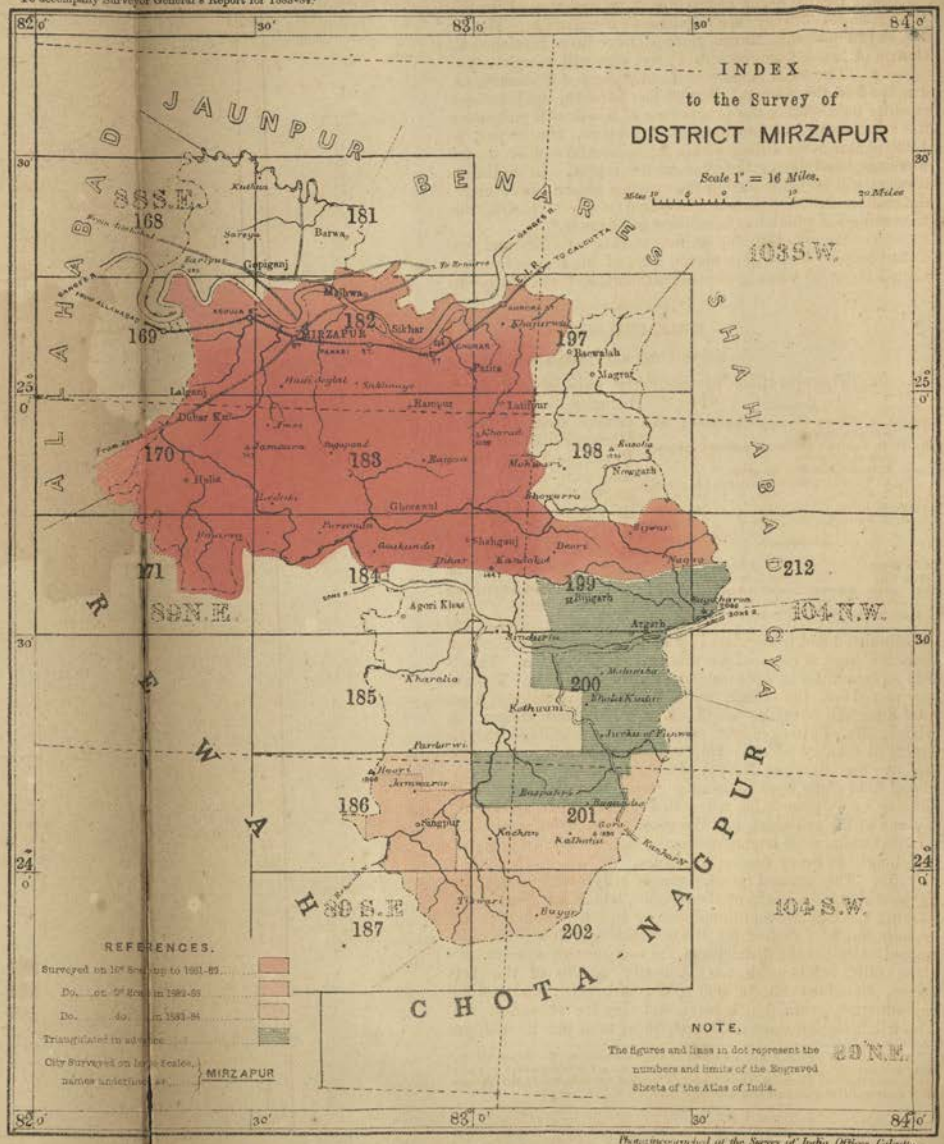
No. 1 TOPOGRAPHICAL SURVEY, GWALIOR & CENTRAL INDIA
BOMBAY TOPOGRAPHICAL SURVEY
PRESIDENCY
MEWAR
MALWA
GUZERAT
KHANDESH
TOPOGRAPHICAL SURVEY
BOMBAY NATIVE STATES
CENTRAL PROVINCES
BERAR
HYDERABAD
Scale 1 Inch = 32 Miles.
Miles
REFERENCES.
Sheets published.
Surveyed during previous Seasons, on Scale of 1 Inch = 1 Mile
Surveyed during 1883-84, on Scale of 1 Inch = 1 Mile
Area Triangulated in advance
Cities Surveyed on large Scales, names underlined as
INDORE
NOTES.
The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India.
Triangulation Chain Degree Sheets are numbered thus

Published under the direction of Colonel H. G. Raikes, R.E., Surveyor General of India,
at the Survey of India Office, Dehra Dún, January 1885.

N. W. PROVINCES SURVEY.

No. 5 TOP. PARTY.

To accompany Surveyor General's Report for 1883-84.



Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S.C., Surveyor General of India.

Survey of India Office, Calcutta, February

1885

In the appendix will be found an interesting description of the country under survey, with particulars and of its inhabitants, chief towns, roads, rivers, &c., by Major Carter.

53. Degree Sheet charts Nos. v, vi, and viii of the Khandesh and Bombay Native States Survey are in course of completion. The data for Degree Sheet No. ix (Bhopal and Malwa Survey) have been furnished to Major Wilmer, in charge of No. 5 Topographical Party, who will complete the report on that sheet.

54. The work made over to this party for survey, as mentioned in paragraph 50 of the General Report for 1882-83, will be completed during the ensuing field season, the programme of which will embrace the detail survey on the 1-inch scale, of portions of Oodeypore, Dungarpur, and Mahikanta, and 1,200 square miles falling within sheets Nos. 58 and 59, the triangulation of which was completed during the year under report. In addition to this, large scale surveys will be made during the ensuing season of the city of Dungarpur and the cantonment of Kherwara, situated in sheet No. 58, the triangulation and traversing for which has been done in advance.*

55. Mr. R. D'Silva, writer, worked steadily and well in the field, but unfortunately died within eleven days of his return from thence. Mr. D'Silva served about 13 years in this department, and was always well reported on.*

MIRZAPUR SURVEY.

(No. 5 Topographical Party.)

56. The operations of this party were of two distinct kinds—the one being a survey on the scale of 2″=1 mile of that portion of country in the Mirzapur district, left unfinished by No. 5 Revenue Survey Party under Colonel Anderson, and the other theodolite traversing round all the village boundaries of the Dudhi pargana for plotting on the 16-inch scale, and also round the villages of certain hilly tracts of Robertsganj, a pargana of the same district, which had not been completed by No. 5 Revenue Party.

Personnel.

Major J. R. Wilmer, Deputy Superintendent, 4th grade, in charge.
Mr. W. H. Patterson, Officiating Assistant Superintendent, 1st grade.
„ C. F. Hauner, Surveyor, 4th grade.
„ E. A. Wainright, Assistant Surveyor, 1st grade.
„ H. T. Kitchen, ditto, 1st do.
„ W. H. Lilley, ditto, 1st do.
„ R. F. Warwick, ditto, 2nd do.

Sub-Surveyors.

Azim Khan, Prem Raj, | Harlal Sing, and four others

Two native non-commissioned officers were also attached to this party during the field and recess season, for instructions in practical surveying.

57. An area of 334 square miles was reconnoitred and triangulated by Major Wilmer himself, completing all the triangulation that is required for this part of the district. This provides an area of 814 square miles in advance for the ensuing season. The area of detail survey completed on the 2-inch scale is 436 square miles of a portion of the Dudhi and Singrauli parganas south of the Keymour range. In addition to the above, Mr. Patterson was employed on the village traverse survey of certain tracts of country which, owing to their hilly and jungly nature, were not taken up by the Revenue Survey Party formerly working in this district. The detail field plans were rigorously tested by 75 linear miles of partals, and almost every plane-table was tested *in situ*, either by Major Wilmer himself or by one of his assistants, and the results have been most satisfactory. Heights of 79 stations were trigonometrically determined, giving an average of about one height to every four square miles.

58. The ground gone over is hilly, undulating, and much cut up by ravines along the banks of the streams, which are densely covered with jungle, making the traverse and detail survey a most laborious task, as lines have to be cut, and rays cleared for every station laid down. This, in addition to the unhealthiness of the district and the comparative scarcity of water throughout these hills, adds much to the costly nature of the survey. During the recess, Standard Sheets 202 N.W., 201 S.E., and 186 N.E. were drawn for reproduction on the 2-inch scale, and also for reduction to the 1-inch scale. The triangulation chart of Degree Sheet ix of the Bhopal and Malwa Survey,

* Major Carter reports well of his assistants and sub-surveyors. Mr. Barker has worked steadily and well, both in the field and office. Mr. Vanderbeck has done a large outturn of triangulation very satisfactorily, and is very trustworthy and reliable in his duties. There has been a marked improvement in Mr. George's work, and sub-surveyors Sheik Omer and Hyder Ali have both done large areas.

which was handed over to this party at the end of the last recess by No. 2 Topographical Party, remains to be completed.

59. The programme for the ensuing season is to continue the 2-inch survey in Standard Sheet No. 200 and to complete the unsurveyed portion of Standard Sheet No. 201, and the traverse survey of the villages of the Dudhi pargana and the forest reserves; also, if possible, to commence the traverse survey of the villages belonging to the family domain of the Raja of Benares, which are situated in the Budohi pargana of this district.

60. As an experiment two native non-commissioned officers* were attached to this party to be instructed in surveying. Major Wilmer reports very favourably of the progress they have made, and suggests that a set of survey instruments should be presented to each of these men, to enable them to carry on the practice of surveying after they return to their respective regiments, so that they may be able to impart to their comrades the knowledge they have acquired. The suggestion is doubtless worthy of consideration.*

* Havildar Kanak Sing, 5th Goorkhas.
Naik Melat Sing, 1st Sikhs.

MYSORE SURVEY.

(No. 8 TOPOGRAPHICAL PARTY.)

61. The party took the field, in the early part of November 1883, to continue the topographical survey of the Mysore province on the scale of 1″=1 mile, and to carry out the survey of the city of Mysore on the scale of 12″=1 mile.

Personnel.

Lieutenant-Colonel H. R. Thuillier, R.E., Deputy Superintendent, 1st grade, in charge up to 12th February 1884.
Major J. R. McCullagh, R.E., Deputy Superintendent, officiating 3rd grade, in charge from 20th March 1884.
Lieutenant H. M. Jackson, R.E., Assistant Superintendent, officiating 1st grade, joined 11th October 1883; in charge from 13th February to 19th March 1884.
Mr. E. S. P. Atkinson, Surveyor, 3rd grade, transferred, 1st August 1884.
Mr. L. J. Pocock, Surveyor, 3rd grade.
„ A. J. James, ditto, 4th do.
„ W. Stotesbury, ditto, 4th do. transferred, 11th June 1884.
„ F. Kitchen, ditto, 4th do.
„ H. Todd, ditto, 4th do.
„ J. Kennedy, Assistant Surveyor, 2nd grade.
„ J. A. Higgs, ditto, 3rd do. transferred, 12th July 1884.
and 10 sub-surveyors.

62. The triangulation has been extended over an area of 1,417 square miles, mostly in the eastern part of the province, but it also included what was required as the basis for the Mysore city survey.

To supplement the triangulation, theodolite and compass traversing to the extent of 187½ miles was conducted within the limits of the Bangalore and Mysore cities, and also in the forest tracts of the Heggaddevankote and Gundlupet taluks which had been triangulated the previous season.

63. The final topography covers an area of 3,975 square miles in the districts of Shimoga, Kadur, Mysore, and Bangalore, and the survey of all this country was as close and minute as the scale would admit of, the average number of plane-table fixings being 11·8 per square mile, in addition to which chain measurements were in some places largely resorted to. It underwent a searching examination by 569 miles of check line, as well as by testings *in situ*. The Mysore city survey was, from the nature of the work, almost entirely carried out by traversing with plane-table and chan. A very large number of supplementary heights were determined, which materially aided in giving a correct delineation of the ground.

64. The country topographically surveyed during the season presents the same variety of features as have been experienced in previous years, from mountains and dense forest to barren, rugged, and rocky hills, merging into open and undulating plains dotted here and there by isolated mounds, and now and again by patches of scrub jungle of considerable size and density. Though in many places more than usual difficulties had to be encountered, they were cheerfully met and overcome by all concerned, and to this circumstance, as well as to the general good health maintained by the party, is attributable the large and successful outturn.

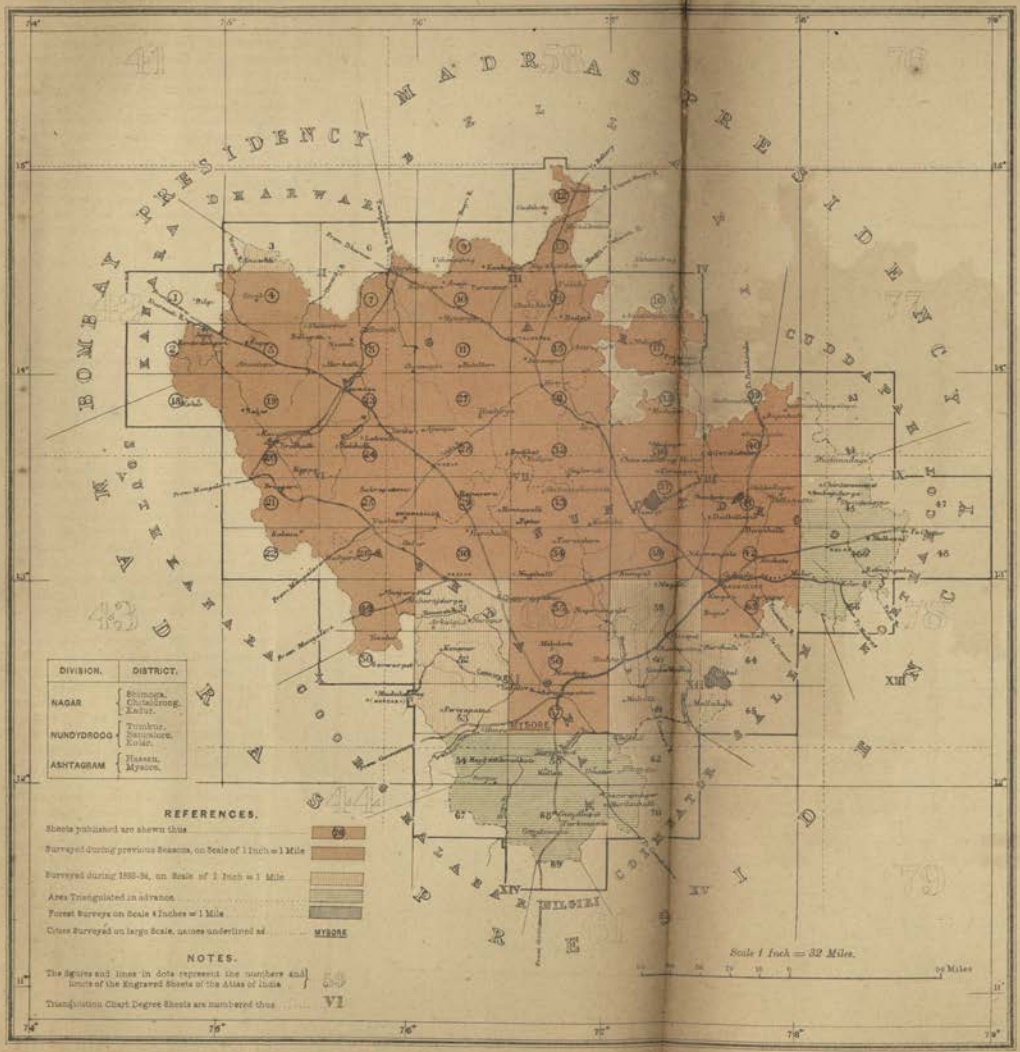
* Major Wilmer reports very favourably of Mr. Patterson's services, Messrs. Hamer, Wainright, Kitchen, and Lilley have also given valuable assistance, and the others have done good work.

No. 8 TOPOGRAPHICAL PARTY.

INDEX TO THE SHEETS OF THE MYSORE TOPOGRAPHICAL SURVEY,

To accompany Surveyor General's Report for 1883-84.

On the Scale of 1 Inch = 1 Mile.


MADRAS PRESIDENCY
BOMBAY PRESIDENCY
HYDERABAD
COORG
MYSORE
DIVISION.
DISTRICT.
NAGAR
Shimoga, Chitaldroog, Kadur.
NUNDYDROOG
Tumkur, Bangalore, Kolar.
ASHTAGRAM
Hassan, Mysore.
REFERENCES.
Sheets published are shewn thus
Surveyed during previous Seasons, on Scale of 1 Inch = 1 Mile
Surveyed during 1883-84, on Scale of 1 Inch = 1 Mile
Area Triangulated in advance
Forest Surveys on Scale 4 Inches = 1 Mile
Cities Surveyed on large Scale, names underlined as
MYSORE
NOTES.
The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India
Triangulation Chart Degree Sheets are numbered thus
VI
Scale 1 Inch = 32 Miles.
Miles

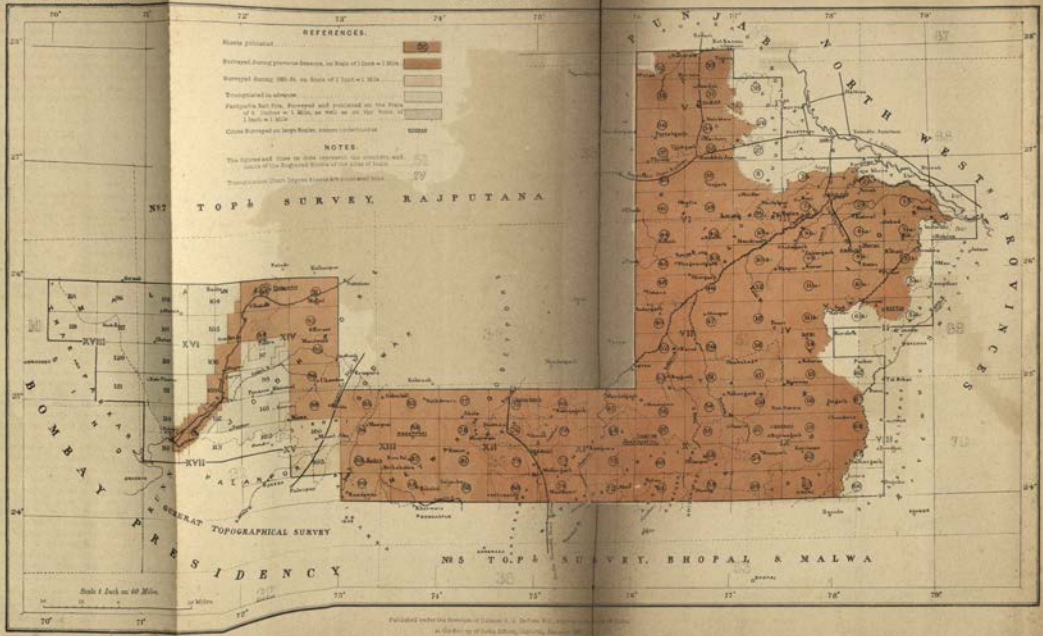
Published under the direction of Colonel H. C. DePree, R.E., Surveyor-General of India,
at the Survey of India Offices, Calcutta, January 1885.

No. 1 PARTY

INDEX TO THE SHEETS OF THE GWALIOR & CENTRAL INDIA TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch to 1 Mile.

To accompany Surveyor General's Report for 1881-82


REFERENCES.
Sheets published.
Surveyed during previous Seasons, on Scale of 1 Inch = 1 Mile.
Surveyed during 1881-82, on Scale of 1 Inch = 1 Mile.
Triangulated in advance.
Parts of the Sub Plts. Surveyed and published on the Scale of 4 Inches = 1 Mile, as well as on the Scale of 1 Inch = 1 Mile.
Cities Surveyed on large Scales, names underlined thus
NOTES.
The figured and lines in dots represent the numbers and limits of the Registered Sheets of the Atlas of India.
Transparencies (Dark Brown Sheets) are numbered thus
PUNJAB NORTH WEST PROVINCES
BOMBAY PRESIDENCY
RAJPUTANA
GUJARAT
MALWA
No 7 TOPL SURVEY, RAJPUTANA
No 5 TOPL SURVEY, BHOPAL & MALWA
TOPOGRAPHICAL SURVEY
Scale 1 Inch to 40 Miles.

Published under the Direction of Colonel S. G. Burrard, R.E., Superintendent of Surveys, in the Survey of India Offices, Dehra Dun, January 1883.

65. During the recess the mapping of Standard Sheets Nos. 3, 51, 52, 53, 59, 60, 61, and 64 has been completed, and a very large amount of computations has been brought up to date. The boundaries on 29 of the published sheets underwent revision, which was necessitated by the alterations made in the limits of taluks and districts in the years following the rendition of the province. Three degree charts and a chart of the special triangulation for the Mysore city survey were got out of hand, and in addition to the ordinary recess duties a satisfactory commencement was made with the large scale survey of the town and cantonment of Bangalore.

66. During the next season the triangulation for the whole of the province will be pushed to a completion. Topography will be continued in the difficult country to the south of the Mysore district comprised in sheets Nos. 54, 58, 62, 67, 68, 69, 70, and No. 65 in the Bangalore district. The large scale survey of Bangalore will also be proceeded with.*

RAJPUTANA SURVEY.

(No. 1 Topographical Party.)

67. This party as proposed in last year's report, was employed on the extension of the triangulation of Degree Sheets Nos. XVI and XVIII, covering an area, in round numbers, of something over 4,000 square miles, a small portion of which was allotted to Mr. Tate, and the remainder was taken up by Major R. Beavan and Mr. A. J. Wilson, who extended the triangulation of a large area in advance of the topography lying near Barmer in the Malani district, and connected the Barmer series with the Jodhpur Meridional series by a network of triangulation.

Personnel.

Major R. Beavan, Deputy Superintendent, 4th grade, in charge.
Mr. A. J. Wilson, Surveyor, 1st grade.
„ W. J. Cornelius, Assistant Surveyor, 1st grade.
„ G. P. Tate, ditto, 2nd do.
„ M. Gastaud, ditto, 3rd do.
„ P. Beechey, ditto 3rd do.

Sub-Surveyors.

Abdul Gafur, | Abdul Aziz,
Golam Mahomed, | and 6 others.
Two military students were also attached to the party for instruction in practical surveying—Daffadar Abdul Rahman, 9th B.C., and Naick Lekram, 5th N. L. I.

68. The bulk of the party was employed on the regular survey on the scale of 1 inch=1 mile, of portions of districts Sirohee and Palanpur, including the sanitarium on the Abu range. It also undertook, at the special request of the political officers, a survey of the Sunda and Dorra ranges of hills on an enlarged scale of 2 inches=1 mile. In addition to the above, the revised survey (for the municipality) of the city and environs of Ajmere on the scale of 12 inches=1 mile was carried on and nearly completed. The triangulation was also executed for the large scale surveys of the cities of Jeypore and Amber, the detail survey of which will occupy a portion of the party during the ensuing field season. This is an extensive survey, but only about one-third of the whole area will be surveyed on the large scale of 12 inches to the mile, the remainder being done on half that scale.

69. The field season lasted six months, from 25th October to 25th April, the result being an outturn of 1,211 square miles of completed detail survey on the scale of 1 inch=1 mile, and 120 square miles on the scale of 2 inches=1 mile, together with the 12-inch survey of the city of Ajmere, and 4,133 square miles of triangulation, a portion of the detail survey of which has been taken up this year, but the greater portion remains as advance work for the ensuing field season. Considering the difficulties of the country to the surveyors on account of the scarcity of water, the paucity of supplies, the dense jungle and the rugged nature of some of the hill features, these results are on the whole very satisfactory.

70. During the ensuing field season the party will be employed on the completion of the revised map of Ajmere, the detail survey of the large scale

* Major McCullagh reports very favourably of the energy and activity of Lieutenant Jackson, R.E., and of the aid he has received from him, and he highly commends the exertions of all his assistants, and especially brings to notice the meritorious manner in which Messrs. Pocock, James, Stotesbury, F. Kitchen, H. Todd, and Kennedy have conducted their duties. The sub-surveyors (with one exception) have done their work very satisfactorily, and the following are mentioned by name:—Janki Dass, Raghavayengar, Tiruvenkatsami, Govindraju, Srinivasayengar, Lachman Daji, Balaji Dhondiba, and Ramasami; also Krishna Rao, the writer of the party.

map of Jeypore city extending to Amber, of which the triangulation has been already done, and the regular detail survey on the 1-inch scale of Standard Sheets Nos 97, 98, 101, and 102; of these No. 97 was partially surveyed last season, but No. 98 has to be done *in toto*. Of Nos. 101 and 102, a portion of which consists of the Sunda hills, and of which the 2-inch survey done last field season can be utilized by reduction to half scale, the remainder of these two sheets will have to be surveyed in detail. Also, if time allows, the topography of the unfinished portions lying between the meridian of 72° and the Luni river survey will be taken up. No further extension of the triangulation will have to be made, as the portion already completed embraces all that is required; but more points will have to be fixed in sheets 97 and 113, and a number of extra secondary and tertiary points fixed for the detail survey of these sheets.*

SOUTH DECCAN, BOMBAY PRESIDENCY.

(No. 11 PARTY, REVENUE BRANCH.)

71. This party was employed in continuing the topographical survey of the South Deccan on the scale of 2 inches to a mile. Field operations were resumed on 1st November 1883 in the Satara district under the direction of Major Andrew, and were continued till the end of May 1884 when the party returned to recess quarters at Poona.

Personnel.

Major D. C. Andrew, Deputy Superintendent, 3rd grade.
Mr. J. Hickie, Assistant Surveyor, 1st grade.
„ R. Todd ditto, 1st do.
„ P. White ditto, 2nd do.
„ G. A. Knight ditto, 2nd do.
20 Sub-Surveyors, and others.

72. The tract of country which has been topographically surveyed during the season comprises an area of 1,831·9 square miles, chiefly within the Standard Sheets Nos. 57, 64, and 65. The survey includes portions of several districts and dependent States, as is shown in the following statement:—

	Square miles.
Sholapur district	11·5
Satara „	1,326·3
Ratnagiri „	159·3
Aundh State	47·7
Vishalgad „	4·5
Sangli „	168·3
Miraj, Senior „	31·1
Miraj, Junior „	28·5
Kurundvad „	25·6
Kolhapur and Southern Mahratta Agency	29·1
Total ...	1,831·9

73. In addition to the above area of detail survey, 1,158 square miles have been triangulated and traversed in advance ready for topographical work next season: a further area of 287 square miles has been triangulated only. The triangulation stations have been well marked by stones embedded in the ground over which rubble platforms have been raised. The traverse stations have been fixed on the trijunctions of fields, which are demarcated by stones about 2½ feet long and 9 inches square: those used as stations have been marked with a cross.

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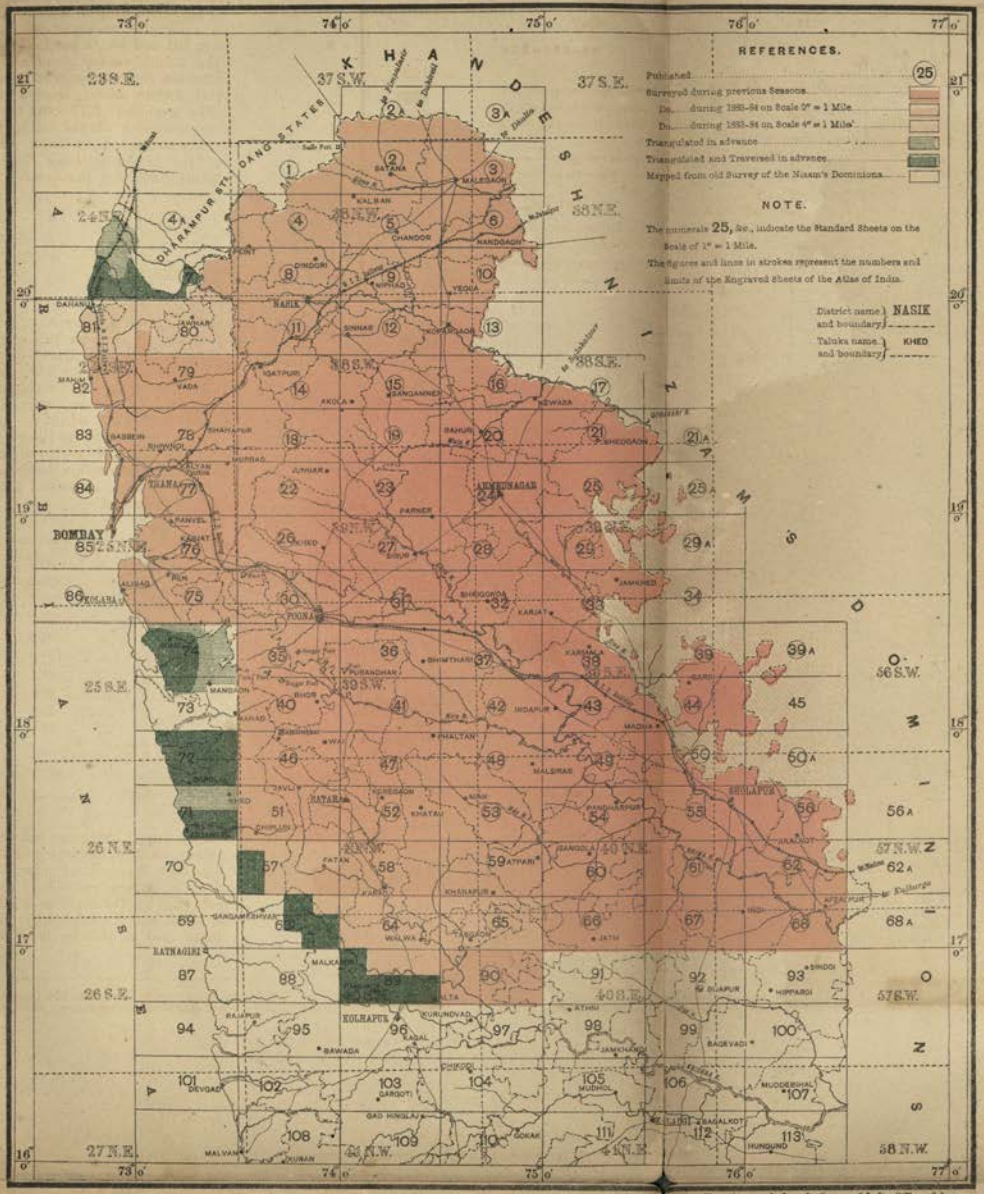
* Major Beavan reports well of all his assistants. Messrs. Wilson and Cornelius, as well as Mr. Tate, have specially contributed by hard and steady work to the success of the season's operations: the sub-surveyors Abdool Gafur, Golam Mahomed, and Abdul Aziz have also done good work.

INDEX TO THE SHEETS OF THE DECCAN AND KONKAN TOPOGRAPHICAL SURVEY.



Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S.C., Surveyor General of India.

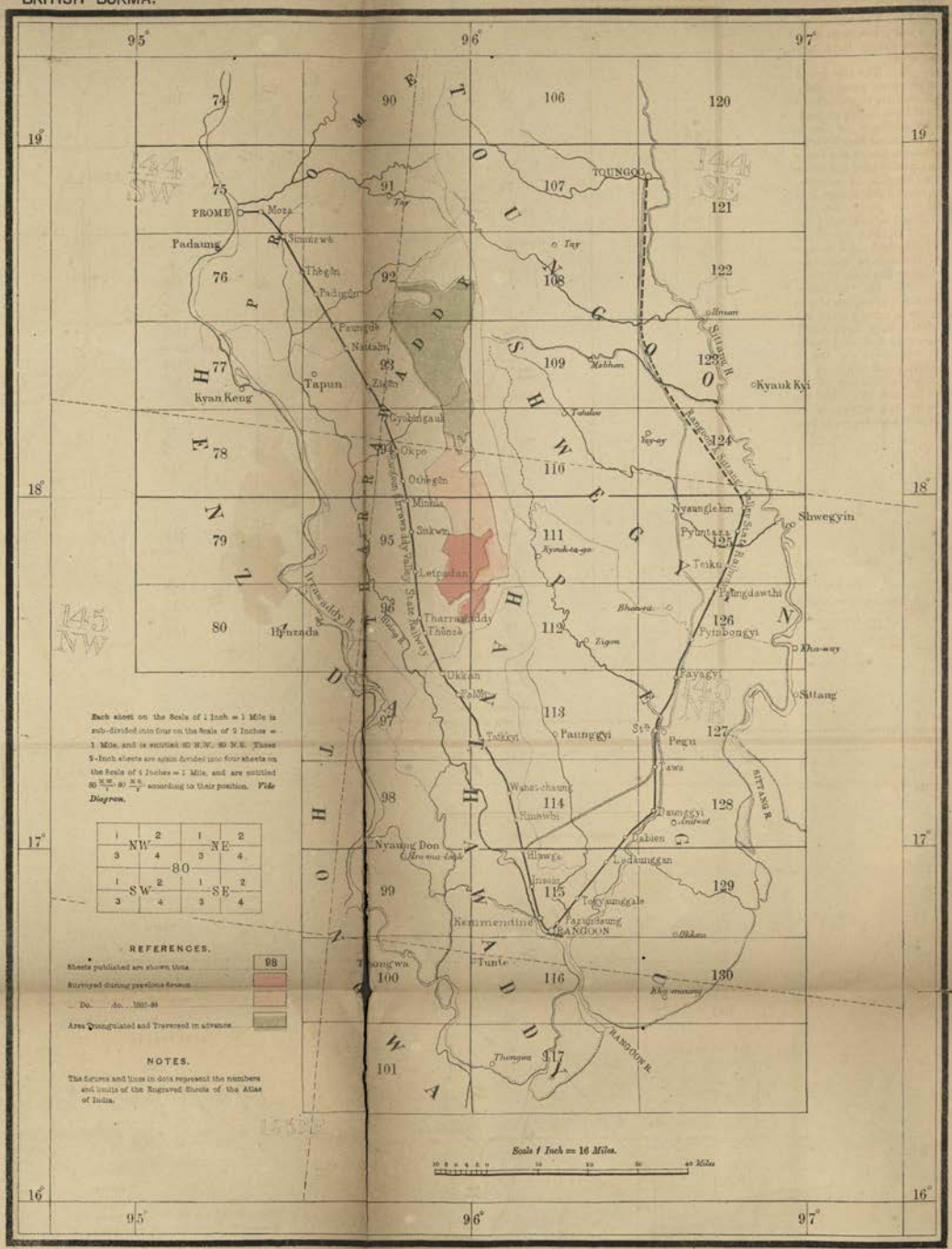
Survey of India Offices, Calcutta, March.

1885

INDEX TO THE SHEETS OF THE BURMA TOPOGRAPHICAL SURVEY

BRITISH BURMA.

On the Scale of 1 Inch = 1 Mile.



Published under the direction of Colonel G. C. De Prée, R.C., Surveyor General of India.
Survey of India Office, Calcutta April 1885.

Photozincographed at the Survey of India Offices, Calcutta.

74. The survey of the town of Pandharpur, on the scale of 80 inches to a mile, has been continued at the expense of the municipality of that town: 8 more sheets have been surveyed, and 15 sheets have been examined in the field.

75. The topographical survey has been carried out on the same lines as in previous years; the limits of cultivation and waste have been shown, and all features represented that the scale would admit of. All village boundaries have been surveyed, and those of the forest also, as far as they were demarcated. The accuracy of the topography has been carefully tested by 160 linear miles of measured check survey in the more level ground, and in the hills by the examination of the field sections *in situ*. Heights have been obtained for all the points fixed by the triangulation, amounting in number to 262, and in addition the heights of several traverse stations have been determined. The country surveyed this season is reported to be more mountainous and difficult than any the party has previously met with. The establishment of sub-surveyors suffered considerably from sickness.

76. The fair maps of the area completed have been prepared, comprising 11 standard-sized sections. The survey of the city and cantonments of Sholapur on the scale of 8 inches=1 mile has been mapped in four sheets, and the reductions to the scale of the Atlas of India have been brought up to date.

77. On the completion of the forest tracts in the Satara district it had been the intention to withdraw this party from the Bombay Presidency for revenue survey work in other provinces. It was expected that the Satara district would have been completed during the last field season, but this could not be accomplished, and as the party is not required for revenue surveys elsewhere, it will complete the Satara district and continue the survey of the Ratnagiri district and adjoining dependent States, and further extend the 2-inch topographical survey of the Bombay Presidency southwards as far as the parallel of latitude 16°. The amount of country that thus remains allotted to this party for survey is estimated at 15,200 square miles, which will probably take the party, as at present constituted, about eight years to accomplish.*

MOUZAWAR AND FOREST SURVEYS.

BURMA FORESTS.

(No. 7 Topographical Party.)

78. This is the second annual report of the operations of this party in Burma. The object of the work, which has been undertaken at the wishes of the Chief Commissioner of British Burma and the Conservator of Forests, is to obtain a first class topographical survey.

Personnel.

Mr. H. Hörst, Deputy Superintendent, 3rd grade, in charge.
Mr. J. H. Wilson, Assistant Surveyor, 1st grade.
„ C. P. Torrens, ditto, 1st do.
„ R. A. Gibson, ditto, 1st do.
„ E. Graham, ditto, 2nd do.

Sub-Surveyors.

M. S. Dutt, M. Shoay Gyoke, Venkat Swamy, and 24 others.

(1). Of the reserved forest tracts in British Burma on the scale of 4 inches=1 mile.

(2). Of unreserved forest and ground likely to be brought under cultivation at some future period, on the scale of 2 inches=1 mile.

(3). Of hilly tracts not coming under the above heads, on the scale of 1 inch=1 mile.

79. The area surveyed lies on the western slope of the Pegu Yoma range in the Tharrawaddy district between parallels of latitude $\frac{17° 37' 3''}{18\ 11\ 15}$ and longitude $\frac{95° 48' 45''}{96\ 7\ 30}$ and embraces 211 square miles on the scale of 4 inches=1 mile, extending over the Thonze, Konbilin, Kadin Bilin, Mokka, and Minhla reserves,

* Major Andrew reports that "the European Assistants, with the exception of Mr. Todd, worked well in the field; all did excellent work during the recess, particularly my Senior Assistant, Mr. Hickie, of whom I cannot speak in too high terms. The sub-surveyors have also greatly improved, particularly in drawing, and are now nearly all qualified to survey accurately in hilly ground."

all of which are completed, except the one last-named, and 52 square miles on the scale of 2 inches=1 mile, including narrow strips of unreserved forest tracts situated between the first class forest reserves and the plains which have been cadastrally surveyed.

80. The area prepared in advance during the first season covered only 108 square miles, and during the season under report 476 square miles were prepared, or 584 square miles in all. Of this, 263 square miles were finally completed, leaving 321 square miles in advance for the ensuing field season.

81. An estimate has not been made of the entire area remaining for survey, but there are about 4,000 square miles of reserved forest lands in the province, which alone would occupy the party some years. Up to date the detail survey of about 350 square miles has been completed. The nature of the country presents extraordinary difficulties to survey operations on account of the almost impenetrable undergrowth. The Pegu Yoma range, forming the eastern limit, is rugged and in many parts inaccessible, and attains a maximum elevation of 2,661 feet at Kambalulaung in the Thonze reserve. There are several high ridges running parallel to the Yoma range, some of which completely overlook it, forming a belt of about six miles in width, west of which there is a sudden fall of from 1,500 to 1,000 feet, covered with primæval forest and cut up with innumerable streams, making the survey of it a most laborious, slow, and tedious task. The Yoma or backbone of the range stands up like a wall above the lower hills, showing a comparative height in a part of the Thonze reserve of more than 2,000 feet in a little more than a mile from the crest. Most of the forest reserves derive their names from the principal streams which flow through them, eventually falling into the great Irrawaddy river.

82. The Commissariat arrangements involve serious responsibilities, as over 600 men have to be provided with all the necessaries of life, which have to be conveyed from great distances on elephants, and stored at central depôts along the line of survey operations. Happily there has been no breakdown hitherto, but there is always more or less risk of such a misfortune occurring.

83. In comparison with the previous field season, during which 26 men out of 364 died, and 40 per cent. of the establishment were prostrated with fever and dysentery, the health of the party this season was fair. The Sub-Surveyors, however, suffered much, and the klassies still more: out of 560 men there were 498 admissions to hospital, of whom 5 died. The greater freedom from sickness this season was owing to the precautions taken to have the camps on elevated spots and to make the men build machans to sleep on.

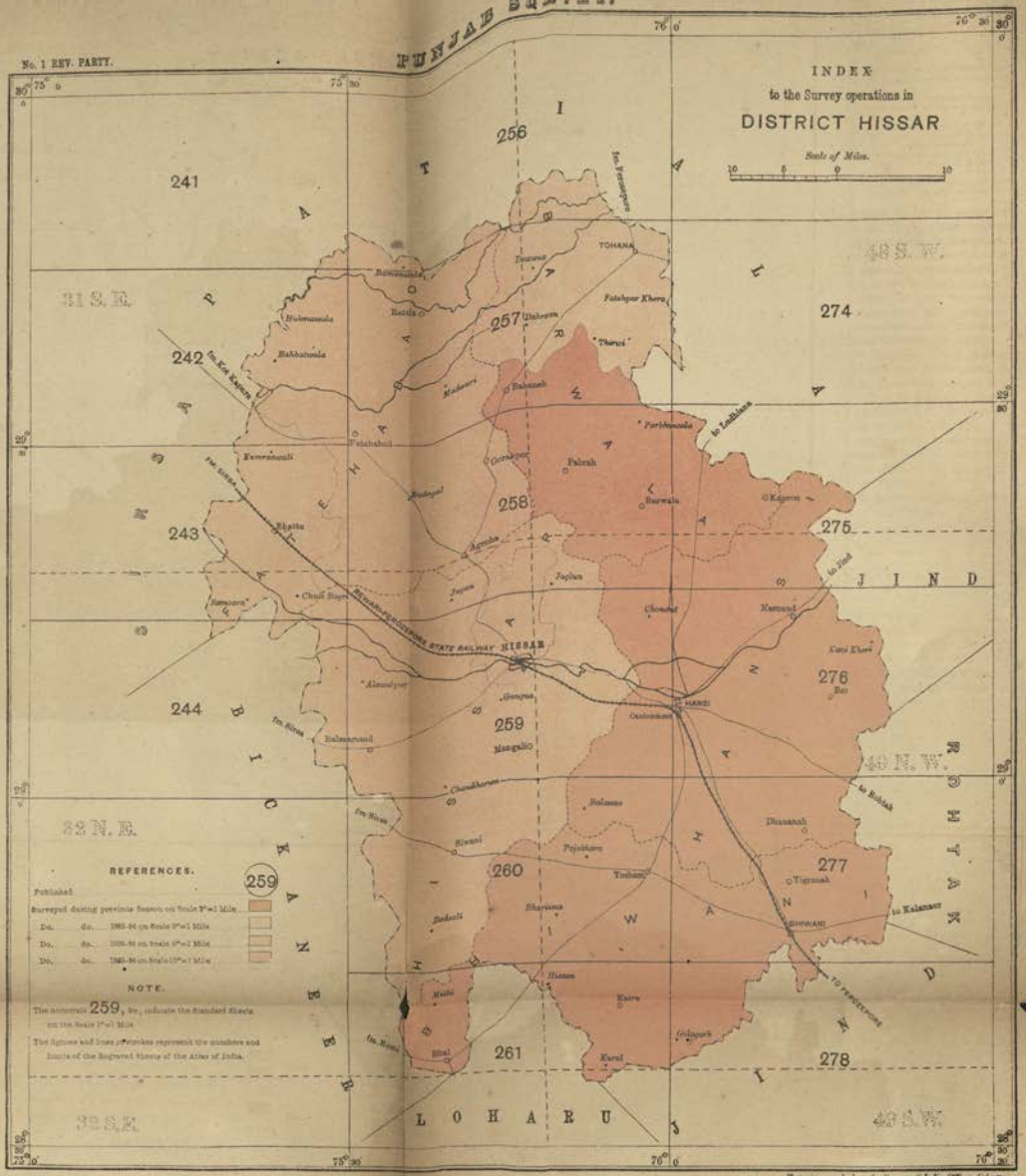
84. The work executed by the assistants and the senior surveyors is of superior quality both as regards accuracy and draftsmanship. Test lines have been run in the work done, and the result is reported by Mr. Hörst as satisfactory. Permanent marks have been left over the ground at half-mile intervals, besides which every tenth traverse post is marked with an iron plate having a number in the Burmese character cut on it: these plates are numbered consecutively from 1 to 1,000, and are supplied by the Forest Department. There is, however, a difficulty about the protection of these traverse stations on the Yoma range, along which wild elephants have formed a track and have pulled up a number of the traverse posts. A narrative report of the country surveyed will be found at page .

85. The programme for the ensuing season will be as follows. As there is no triangulation in advance of the traverse survey, the area to be triangulated will proceed *pari passu* with the traverse survey, chiefly in the Prome civil district, including Shwele, Myodaung and the Shwedaung townships, comprising 125 square miles. The detail survey on the scale of 4 inches=1 mile will be continued from where it was left off last field season, and will be almost entirely confined to the Tharrawaddy district, including a number of forest reserves, embracing an area of between 300 and 400 square miles, and if time permits, the detail survey of the hilly tracts in the Shwedaung township of the Prome district will also be proceeded with.*

* Mr. Hörst reports very favourably of his assistants, Messrs. Wilson, Torrens, Gibson, and Graham, and that the sub-surveyors generally, under the circumstances, did fairly well, although the areas turned out by each individual were necessarily very small on account of the heavy line cutting and jungle clearing.

PUNJAB SURVEY.

No. 1 REV. PARTY.



Published under the direction of Colonel G. C. De Prée, R. C., Surveyor General of India
Survey of India Office, Calcutta. February
1885

Photozincographed at the Survey of India Office, Calcutta.

HISSAR DISTRICT, PUNJAB.

(No. 1 Party, Revenue Branch.)

86. This party left its recess quarters at Murree on the 10th October under the charge of Colonel D. Macdonald, who conducted the field operations up to 2nd March 1884, when he proceeded on furlough, and was relieved by Lieutenant-Colonel F. Coddington, under whose supervision the party has since remained.

Personnel.

Lieutenant-Colonel D. Macdonald, Deputy Superintendent, 2nd grade, in charge up to 2nd March 1884.
Lieutenant-Colonel F. Coddington, Deputy Superintendent, 2nd grade, in charge from 3rd March 1884.
Mr. W. S. Buttress, Surveyor, 3rd grade.
„ A. J. Gibson, ditto, 3rd do. up to 31st December 1883.
„ G. Campbell, Assistant Surveyor, 1st grade.
„ E. B. M. Drew, ditto, 2nd do.
„ J. P. Barker, ditto, 3rd do. from 22nd December 1883.
24 sub-surveyors and others.

87. The survey has been continued on the procedure adopted under the orders of Government in the previous year, the operations comprising a topographical survey on the scale of 2 inches to a mile, combined with a system of skeleton traverses to aid an approaching settlement survey. Full particulars of this system were given in last year's report of the operations of this party: briefly stated, the traversing follows village boundaries, in the interior of which sub-traverses are run at distances of about half a mile apart, furnishing fixed points at short intervals, all of which are permanently marked. From the data obtained of these points skeleton plots can be prepared on any required scale, and these will furnish an efficient frame-work for the cadastral survey of fields to be undertaken by the *patwaris* of the district under the superintendence of the Settlement Department.

88. Operations were commenced on 15th October 1883, and brought to a close on 10th April 1884, on the completion of the survey of the Hissar district, which has thus been successfully carried out in two years, according to the original estimate, although considerable drains had to be made on the establishment during the field season to assist in the formation of a detachment demanded for special urgent operations in Rajputana.

89. In addition to the 2-inch topographical survey of the district, the Government Cattle Farm at Hissar has been surveyed on the scale of 6 inches to a mile for the Commissariat Department, and the civil station and city of Hissar on the 12-inch scale.

90. The areas surveyed on the different scales during the past season are given in the following statement:—

Hissar district	...	...	2-inch scale—	1,782	square miles.
„ farm	...	...	6 „ „	64	„
„ station and city		...	12 „ „	4	„

An overlap survey of a belt of country, half a mile in width, was also made in the adjoining districts to ensure a good connection with the surveys thereof.

91. The nature of the country in which the topography has been executed is similar to that met with in the previous year, being for the most part very open, with few topographical features, and is essentially easy for survey. The plane-tabling has been tested by 249 linear miles of check survey, and the comparison proved the work to be good. Twenty-one miles of spirit-levelling were also run to connect the levels of the Irrigation Department and of the Railway with those of the Trigonometrical Survey.

92. The village boundary traversing covered an area of 811 square miles, while the internal sub-traverses embraced 2,011 square miles. No fresh stations of the Trigonometrical Survey fell within the area of the year's operations; consequently there are no comparisons of distances available. The connections, however, that were made during the previous season, with 29 trigonometrical stations, secured an accurate basis for the extension and completion of the traverse work.

93. Previous to the commencement of survey operations, the trijunctions of village boundaries were marked by "boorjas," or high conical pillars. These were found to be unsuitable for use as traverse stations, and were therefore removed and replaced by masonry platforms which have been used throughout for theodolite stations. The permanent marking of the stations of the boundary traverses, and of the extra traverses for the Settlement Department has been systematically carried out. On this subject Lieutenant-Colonel Coddington reports as follows:—

"During the previous year, in an area of 3,000 square miles, the traverse stations had been marked with concrete blocks, in size 18″ × 6″ × 6″, at a cost of Rs. 11,512-10-4. The remaining portion of the district was similarly marked during the past year, at a cost of Rs. 1,338-7-10. Thus the total cost of marking all the traversed points in the district has been Rs. 12,851-2-2, at an average cost per square mile of Rs. 3-10-7. For this outlay 19,623 concrete blocks have been embedded. Of this number 8,218 are situated on village boundaries, and 11,405 in the interior of villages. The cost per block, including manufacture, conveyance, and embedding, has averaged 10 annas."

Copies of the data of all the permanent points on the village boundaries, as well as those on the internal lines, have been prepared for the Settlement Department, together with an index plot, on which every marked point has been shown.

94. The mapping of the season's 2-inch topography in Hissar is embraced in 28 standard-sized sections which have been prepared in duplicate, one set being for reproduction to scale, and the other for reduction to the 1-inch scale. The cattle farm on the 6-inch scale has been drawn in nine standard-sized sections, and the city and civil station on the 12-inch scale in two similar sized sections.

95. The publication of the maps of the Murree and Kahuta tahsils of the Rawal Pindi district on the 4-inch scale, the survey of which was executed by this party prior to the Hissar survey, has been deferred for the insertion of the boundaries of the forest reserves which are in the course of adjustment by the Settlement Department. The necessary information has been received for 15 sheets, which number has now been completed. It is anticipated that the boundaries in the remaining 19 sheets will be decided, and the maps finished during next year.

96. Owing to the want of orders regarding the future employment of this party, no preliminary traversing has been prepared. It was originally intended that the survey of the Ferozpore district should be taken up in succession to, and on the same system as that carried out in Hissar. From the experience gained there, however, it is considered that in the plains of the Punjab, where the country is open and the physical features simple, such an elaborate system of traverses is not necessary, and that fewer fixed points will be sufficient to base subsequent cadastral operations.

97. The Punjab Government, on financial grounds, also demanded the restriction of the scientific work to the lowest necessary limit. Proposals were made by the Settlement Commissioner changing materially the scope and nature of the future operations in the Punjab.

The principal features of the procedure recommended are—

I.—A modified skeleton traverse survey, utilizing trijunction platforms for stations and fixing two in each village.

II.—The topography for revised 2-inch maps of the province, to be taken from the settlement maps, the details being tested and added to where wanting.

III.—A scientific survey of all the riverain tracts in the Punjab which are subject to fluvial action.

These proposals have received the sanction of the Government of India, and during the next field season detachments of this party will be engaged in the districts of Ferozpore, Umballa, Jallandhar, and Ludhiana on the various operations detailed above.*

* Colonel Coddington reports favourably of his assistants, both European and native, and commends the exertions of Messrs. Buttress, Campbell, and Barker. The following members of the native establishment are said to deserve mention, viz.- Ramtonor Chakerbutty, Elahi Bux, Ayid Mahomed, and Sirajudin.

THANA DISTRICT, BOMBAY PRESIDENCY.

(No. 10 Party, Revenue Branch.)

98. The field operations of this party were resumed on the 5th December 1883, under the direction of Major J. Hill, R.E., who remained in charge till 5th May 1884, when, his services being required for the exclusive superintendence of the Tidal and Levelling operations, Mr. A. M. Lawson, the senior assistant, was placed in temporary charge, and under his supervision the field operations were brought to a close and the recess duties conducted till the 2nd October 1884, when Major Hill resumed the charge.

Personnel.

Major J. Hill, R.E., Officiating Deputy Superintendent, 3rd grade, in charge up to 5th May 1884.
Mr. A. M. Lawson, Surveyor, 2nd grade, officiating in charge from 6th May 1884.
Mr. J. Newland, Assistant Surveyor, 1st grade.
„ W. M Kelly, ditto, 1st do.
„ R. R. Dickinson, ditto, 1st do.
18 Sub-surveyors and others.

99. The operations of this party have been of two descriptions during the year: 1*st*, the survey of the Thana Collectorate on the 4-inch scale, which has been continued under the same conditions as in the previous season, which are described in paragraph 130 of the last Annual Report; and 2*nd*, the 2-inch survey of the Jáwhár State, situated within the Thana Collectorate, wherein close survey has been made of the topographical details, omitting village boundaries. The index map will be found at page 22.

100. The area surveyed on the 4-inch scale in the Thana district is 612 square miles, and on the 2-inch scale, 288 square miles in the Jáwhár State has been completed. In addition to the area which has been mapped, preliminary triangulation and traversing has been extended over 460 square miles for the detail survey next season, and triangulation alone has been executed over a further area of 220 square miles in advance.

101. The country surveyed lies between the Western Ghats and the sea and between the parallels of 19° 45′ and 20° latitude. It includes the Mokáda sub-division and a portion of the Dáhánu taluka of the Thana district and of the Jáwhár State. Regarding this tract Mr. Lawson reports as follows:—

"The country surveyed last season was exceedingly difficult. With the exception of a strip along the coast, it was very hilly and intricate, being cut up in all directions by deep gorges, the sides of which are covered with forest. This part is notoriously unhealthy for two or three months after the rains. It became necessary therefore to employ the Surveyors as much as possible in the more open tracts during the early part of the season, but although the party undoubtedly benefited by this arrangement, there was still a great diminution in the outturn during December and January owing to the prevalence of malarious fever."

A description of the country by Mr. Lawson is given in the appendix to this report, and conveys a good idea of the difficult tract over which the operations have been extended.

102. Throughout the survey on the 4-inch scale all the village boundaries have been determined by actual survey: the comparison thereof with the settlement maps confirms the result obtained during the previous season, viz. that the provincial maps are reliable in flat country, but that those in hilly ground are very inaccurate.

103. The traverse survey has fixed 2,992 points, of which 432 are village trijunctions, and stones are embedded at the remaining points with a special mark cut on them. The heights of 372 points in the Thana district and 94 in the Kolába district have been determined trigonometrically, and verified by connection with the bench marks of the Tidal and Levelling operations. The accuracy of the detail survey has been tested in the plain country by 190 linear miles of check survey, and in the hilly country by *in situ* examination of the details from selected points.

104. The plan adopted during the previous year by Major Hill of utilizing the original field sheets of the 4-inch scale sections, as the means of reproduction, so as to avoid the labour of re-drawing them during the recess, and to obviate the danger of the mapping falling into arrears, has been kept in view during the past season and with good results. On the whole outturn of field work on the 4-inch scale, 74 per cent. has been passed as fit for reproduction. The great saving in the labour of drawing thus obtained has enabled the publication of the maps to keep pace with the survey.

105. The following maps have been prepared during the recess:—44 sections of the standard size on the 4-inch scale comprised within sheets Nos. 79, 80, 81, 82, for reproduction to scale; 7 sections of sheets Nos. 79 and 82 on the 2-inch scale for reduction to 1-inch. In addition to the above, 52 skeleton maps on the 4-inch scale, showing village boundaries and traverse stations, have been prepared for the Settlement Department.

106. The work remaining for this party in the Thana and Kolába districts will be completed during the next season, after which, according to present arrangements and the orders of the Government of India, it will be employed in the portion of the Bombay Presidency, south of the parallel of 16°, which comprises Belgaum, Dhárwár and Kárwár.

107. Mr. Lawson acknowledges the valuable assistance obtained from His Highness the Raja of Jáwhár while the party was employed in his State.

108. The recess office of this party was inspected by the Surveyor-General at Poona in November 1884, who formed a favourable opinion of the mapping and the careful and business-like arrangements of Major Hill's superintendence.*

CADASTRAL OR FIELD SURVEY.

AJMERE-MERWARA DISTRICT, RAJPUTANA.

(DETACHMENT FROM NOS. 1 AND 3 PARTIES, REVENUE BRANCH.)

109. The revision of the settlement of Ajmere-Merwara having become necessary, the assistance of the Survey Department was asked for to ensure the construction of sufficiently accurate maps. A meeting was held at Nusseerabad between the Surveyor-General and the Commissioner, and the Settlement Officer of Ajmere-Merwara, to discuss the question of the system of survey to be adopted, when the following facts were elicited:—

(1) In Ajmere, over a large area there are no permanent fields, the cultivated area being always shifting, while in Merwara, among the hills, the fields are more permanent, but there also the cultivation is continually being added to.

(2) The area to be dealt with is—

Ajmere (excluding *istimrar* and *jagir* estates)...	560	square miles.
Merwara	640	ditto.

The problem to be solved was to obtain a survey which should furnish maps that can be reproduced. It was clear that a cadastral survey, however accurate, would, owing to the shifting nature of the cultivation, soon became obsolete in most of its features, and was therefore inapplicable. It was considered that the only other method suitable would be a traverse and village boundary survey, under which system fixed points would be established by professional traversing, and skeleton maps provided showing the boundaries of each village and the position of each permanent mark within it, and on these data the local surveyors (*patwaris*) would be able to map in the cultivation at the time of their survey. The skeleton maps would be reproduced by photo-zincography or lithography, so that whenever maps of the time of survey became obsolete, fresh skeleton maps would be available on which the *patwari* could carry out the new field measurements.

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* Major Hill has reported on the services of his assistants as follows:—

"Mr. Lawson's work during the field season was, as usual, most satisfactorily performed. * * * * During the time he held charge he has carried on the work remarkably well. He has now held charge of the party on three different occasions, and in each instance I have had every reason to be well satisfied with the way in which he performed his duties.

"Mr. Newland performed his duties most efficiently and satisfactorily.

"Mr. Kelly has worked well, and has turned out a considerable amount of work, all of which is carefully executed.

"Mr. Dickinson has, as usual, worked very satisfactorily, both in the field and in office * * * and is well deserving of promotion."

Of the native establishment, "the office assistant and sub-surveyors, with the exception of one traverse surveyor, have all done good work."

AJMERE DETACHED PARTY.

AJMERE MHAIRWARA.

Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S. C., Surveyor General of India.

Survey of India Offices, Calcutta, February

1885

110. This system of survey, which appeared to be the most suitable one for the special circumstances of the country, was approved by the Government of India. The Deputy Surveyor-General reported that surveyors were not available to be sent to Ajmere, as their withdrawal from other districts would seriously interfere with the work in progress, and recommended that for the current field season the work in Ajmere should be resricted to the demarcation of the village boundaries and the cultivated tracts by the district authorities, and that a strong survey party should undertake the survey at the beginning of the next season. The Government of India, however, considered the survey of Ajmere of great urgency, and directed that a small party should be immediately deputed there.

111. Orders were then issued on 13th December 1883 to the officers in charge of Nos. 1 and 3 Revenue Parties to arrange for a detachment to proceed to Ajmere to undertake the work.

Field operations were commenced on 7th January 1884 by the first portion of the detachment in tahsil Todgarh, at the extreme south of Merwara, and the remainder of the detachment broke ground on 17th idem. The strength of the full detachment is given in the margin, and the Deputy Superintendent, in charge No. 1 Party, was directed to exercise general superintendence over the work. This superintendence was subsequently transferred to Major E. H. Steel, Deputy Superintendent, 4th grade, who has supervised the operations since 27th January 1884. The field work was continued till 13th April.

Personnel.

Mr. A. J. Gibson, Surveyor, 3rd grade, in charge.
Mr. C. W. Seyers, Assistant Surveyor, 1st grade.
Seven Sub-surveyors.

112. The area completed in both boundary and interior traverses amounts to 91 square miles, while an area of 63 square miles in advance has been partially traversed. The boundary traversing comprises 288 linear miles, and the interior traversing 145 linear miles. The triple junction-marks of villages and other boundary pillars have been utilized as far as possible for theodolite stations. All the stations, 742 in number, of the interior traverses have been permanently marked by stones projecting about a foot above the ground.

113. The main traverses have been connected with trigonometrical stations and the measurements made to accord therewith. For this purpose some minor triangulation has been carried out by Mr. Gibson, in which four new stations were fixed. Azimuth observations have been taken at 11 stations to check the angular work of the traverses.

114. A good deal of trouble and delay arose from a disturbance between the villagers of Birjal in British territory and those of Deogarh in the Oodeypore State regarding a disputed boundary, which they would not allow to be surveyed. The Assistant Commissioner requested that the survey parties might be withdrawn, which was done, and the boundary still remains unsurveyed.

115. The outturn of work is small, but it is as much as could reasonably have been expected considering the small and inadequate establishment that was employed, and that it was hurried into the country late in the season, whereby it worked under great disadvantage, and that the operations were limited to a short field season of three working months. Moreover, the country was very difficult for traverse operations, the ground being hilly and very rough in parts, and some delay was experienced in clearing jungle for the traverse lines.

116. Skeleton maps, on the scale of 16 inches to a mile, of the season's work, which comprises 19 villages in 45 sheets, have been forwarded to the Settlement Officer.

117. As the settlement survey of Ajmere district is to be finished by March 1886, it was requisite that the Survey Department should complete the boundary and traverse survey during the season of 1884-85 and furnish the Settlement Officer with skeleton maps of all villages by October 1885. To enable this work to be completed, a full party under the immediate charge of Major E. H. Steel has been deputed to Ajmere for the current season.*

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* Major Steel speaks in favourable terms of Mr. Gibson, who, he says, is a very hard-working and painstaking assistant.

Mr. Gibson reports as follows:—"Mr. Seyers has worked during the field season in a most energetic manner * * * and has at all times been most willing to assist me." "The sub-surveyors have all worked fairly, but they were inexperienced in the kind of work they were employed on."

BASSEIN AND HENZADA DISTRICTS, BRITISH BURMA.

(No. 8 Party, Revenue Branch.)

118. This party, the strength of which is given in the margin, continued under the superintendence of Major Hutchinson throughout the year. The traversing section left Rangoon for the field on 15th November, and the cadastral sections followed on the arrival of the establishment from India on 24th November and 10th December 1883. Field operations were resumed in the Bassein and Henzada districts, and were continued until 15th May 1884, when the party returned to recess quarters in Rangoon.

Personnel.

Major H. S. Hutchinson, Deputy Superintendent, 4th grade.
Mr. H. R. Littlewood, Surveyor, 2nd grade.
„ H. Dowman, ditto, 3rd do.
„ R. B. Smart, ditto, 4th do.
„ T. H. Dunne, Officiating ditto, 4th do.
„ W. H. Penrose, Assistant ditto, 1st do.
„ W. H. D. Ewing, „ ditto, 3rd do.
28 Sub-surveyors and others.

Temporary Establishment

136 Field surveyors and others.
2 Levellers.

119. The cadastral survey in the Bassein district has been nearly completed, and it has been extended in the Henzada district. The completed areas in the different townships in each district and the total areas are shown in the following statement:—

Districts.	Townships.	Number of kwins.	Area in square miles.
Bassein	Kyone-kazin	3	4·60
	Lemyet-hna	60	76·99
	Ye-gyi	44	72·34
Henzada	Zaloon	34	194·23
	Henzada	131	259·52
	Oke-po	46	150·29
	Total ...	318	757·97

In addition to the above, preparatory boundary traversing for the cadastral survey next season has been extended over an area of 693 miles. In the cadastral operations, a much larger proportion of cultivation to the waste land came under survey this season. Of the 758 square miles of cadastral work, 470 square miles is rich cultivation, containing 7,23,810 fields, nearly two lakhs in excess of last year, having an average area of 0·41 of an acre. The country is said to be perfectly flat and much intersected with water. A portion on the right bank of the Ngawun river, in the Bassein district, along the foot of the Yoma hills, contained much jungle and swampy land, and was a difficult piece of work.

120. By request of the local Government a special survey of the Oke-po coal field, situated in the hills near Oke-po, was attempted by a small detachment which commenced operations at the end of October. The ground, however, presented great difficulties, and was so covered with dense jungle that extensive line cutting had to be undertaken for the survey. The locality, moreover, was very unhealthy, and after a month's hard work the survey had to be abandoned, as all the men were prostrated by fever.

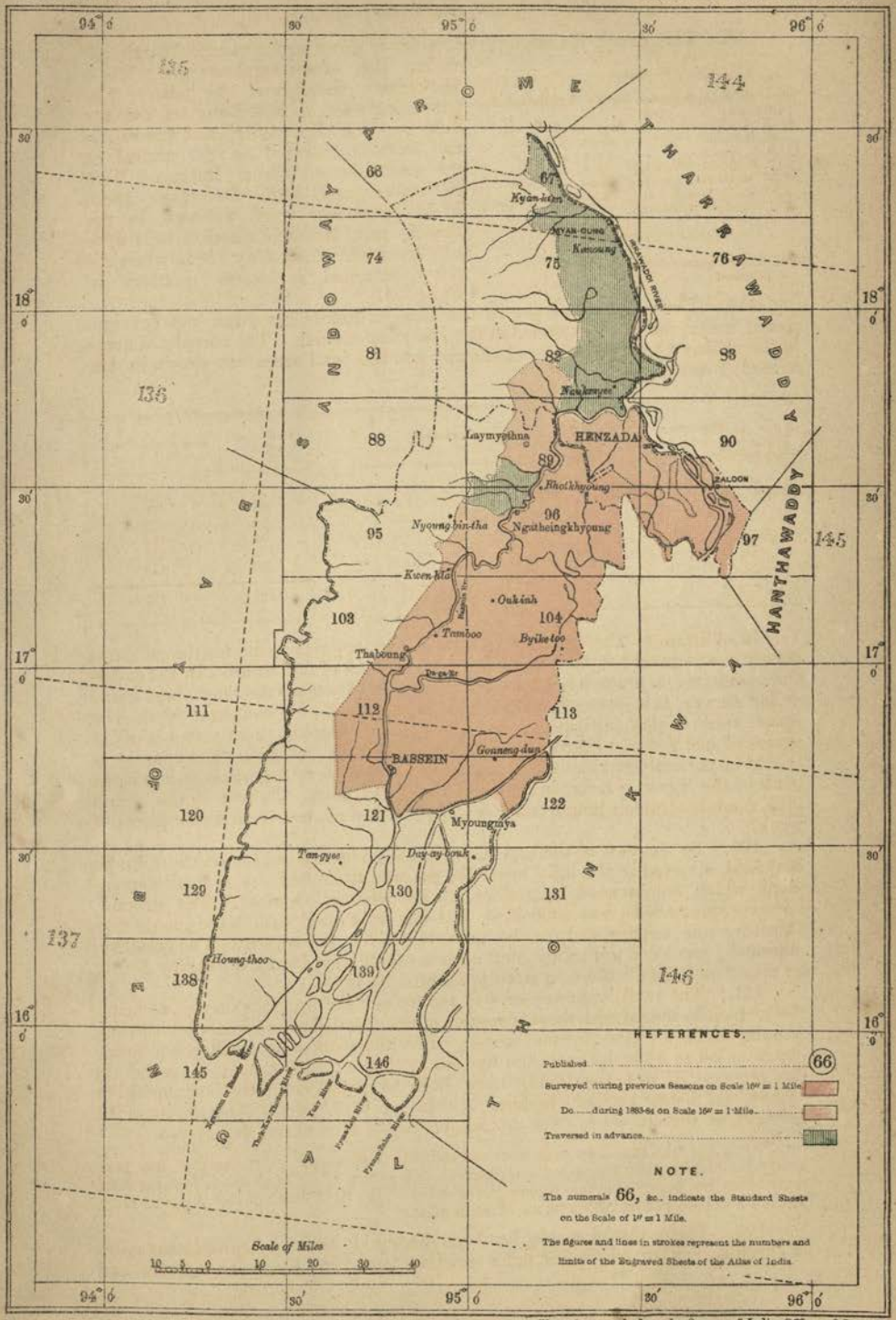
121. The revision survey of 648 square miles of previous survey, to bring the maps into accord with the settlement papers, entailed even greater labour than was experienced in the previous season, when that work was considered a heavy one, and led to a special provision by the settlement department to assist in the process: 37,644 new fields have been surveyed, and the boundaries of 31,884 old fields revised, making a total of 69,528 fields operated in, or 11 per cent. of the old work. On this subject Major Hutchinson reports:—

"Only one who has done this work can estimate the labour it involves; it has been a very heavy drag upon our season's outturn of new survey * * * * and was indeed the main cause of my not being able to complete the ground on the right bank of the Ngawun river, which I had been particularly anxious to accomplish."

122. The cadastral survey has been thoroughly tested by 1,068 linear miles of check survey, of which 281 miles were measured by European officers and

INDEX TO THE

No. 8 REV. PARTY. BRITISH BURMA CADASTRAL SURVEY. DISTRICTS BASSEIN & HENZADA.



Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S.C., *Surveyor General of India.*

Survey of India Offices, Calcutta, March

1885

787 miles by native agency. The Deputy Superintendent constantly visited the field camps and inspected the field surveyors as much as possible. The traverse work has been connected with six stations of the great trigonometrical survey, and the chain measurements made to agree with the triangulation distances. The angular work has been checked by azimuth observations at 82 stations. The correction on the chain measurements averages 12 links per *mille*, and the angular correction averages one minute per 10 stations. The traverse work in the Henzada district has been connected with the work of the Prome and Tharrawaddy cadastral survey near the junction of the three districts, with very satisfactory results; the linear difference being 1·52 chains and the angular difference 2′ only.

123. Permanent marks consisting of pottery cylinders have been embedded at all the traverse stations, and special arrangements have been made this year to ensure their proper protection. On this subject Major Hutchinson reports:—

"Every traverse surveyor has kept a field plot of his work on the 2-inch scale, and as he passed from village to village, he handed over a trace from this plot to the headman of the village, telling him that so many marks had been placed on his boundary for which the Government would hold him responsible, and taking his signature as a token that he had received this warning. From these field plots a chart was kept up in the survey office, and as each circle was completed a copy of the same was furnished to the Deputy Commissioner's and settlement offices.

"One copy of each individual village was separately prepared on Government stamped paper bearing the settlement officer's signature: these were sent as soon as possible to the settlement office for distribution to the village headmen, together with a copy of the Government order under which they are made liable for the protection of these marks. It is hoped that these precautions will do much to preserve our stations, but the inherently mischievous character of the Burman has, I fear, already in some instances rendered them futile."

124. The instruction of Burmans in surveying has been continued with marked results. Eighty pupils have been attached to the party, and of these 63 qualified for survey certificates. This was considered very satisfactory by the local Government, and elicited the thanks of the Chief Commissioner to Major Hutchinson and to his assistant, Mr. Littlewood. The training of the indigenous agency by this survey party was started, however, by Major Steel three years previously, and continued in the following years by Lieutenant-Colonel Wilkins. The general question of the capabilities of Burmans for survey employment has been recorded in previous reports of this party, and Major Hutchinson states that it does not call for further comment. The general employment of Burmans as field surveyors, Major Hutchinson considers, "has only to be tried in order to be abandoned." Burmans seem to succeed better as theodolite surveyors, for Major Hutchinson reports that "six men worked with us through the season: three of these did first class work, and three fair work. Their rate of progress was slow, but it was sure and accurate."

125. A survey school was opened at Henzada. Major Hutchinson writes:—

"It does not seem to have attracted very many scholars, and might with advantage, I think, be dispensed with, certainly after this survey party leaves the district, as the Bassein school suffices for the Irrawaddy division."

126. Two squads of levellers have been attached to the party, and their work is reported on with the other levelling operations of the department, at page 54.

127. The 16-inch sheets, 773 in number, of the area where the settlement and revision survey operated, have been submitted to Calcutta to be photozincographed, as well as 48 sheets of the Bassein town survey. The manuscript traces with field area statements of the cadastral maps of the present survey have been supplied to the settlement officer. The general maps on the 2-inch scale of this season's area have not yet been completed.

128. This party is to continue operations at reduced strength to complete the survey of the Henzada district during the next season. The boundary establishment which had completed its work in Henzada was therefore withdrawn, and it has been absorbed among other parties in India. The reduced

party, according to present orders, will be withdrawn from Burma in October 1885, leaving a small detachment behind to excute the settlement revisions during 1885-86.*

BENARES AND BASTI DISTRICTS, NORTH-WEST PROVINCES.

(No. 4 PARTY, REVENUE BRANCH.)

129. This party resumed the cadastral survey of the Benares district, which has been completed, and commenced similar operations in district Basti. Major Barron's health having failed, he was granted furlough to Europe, and the party was conducted into the field by Mr. G. H. Cooke, who superintended the field operations till 10th December 1883, when he was relieved by Major Cowan, under whose charge the subsequent operations have been carried on.

Personnel.

Major W. Barron, s.c., Deputy Superintendent, officiating 2nd grade, in charge from 1st to 31st October 1883; on furlough from 9th November 1883.
Major S. H. Cowan, s.c., Deputy Superintendent, 4th grade, in charge from 11th December 1883.
Mr. G. H. Cooke, officiating Deputy Superintendent, 4th grade, in charge from 1st November to 10th December 1883. Doing duty from 11th December 1883 to 16th August 1884.
Mr. H. T. Hanby, Surveyor, 3rd grade.
,, W. C. Price, ditto, 4th do.
,, S. O. Madras, Assistant Surveyor, 1st grade, up to 26th April 1884.
Mr. E. P. S. Hill, Assistant Surveyor, 1st grade, joined 3rd May 1884.
Mr. L. F. Berkeley, Assistant Surveyor, 2nd grade.
Mr. G. S. Willes, Assistant Surveyor, 3rd grade, up to 1st October 1884.
Mr. B. R. Hughes, Assistant Surveyor, 3rd grade, joined 15th October 1883.
Mr. W. E. Johnson, Assistant Surveyor, 3rd grade, joined 18th August 1884.
25 Sub-surveyors and others.

Temporary Establishment.

338 Field surveyors and others.

130. In Benares the field work commenced on 20th October 1883, and progressed steadily throughout until the completion of the survey on 27th April 1884, when the main party returned to recess quarters at Naini Tal. In district Basti operations were commenced in January 1884, but as the conditions there were less favourable than in Benares, the area taken up for detail survey was not completed till the end of May, a small detachment remaining in the field throughout that month.

131. In the Benares district the survey of the Chandauli tahsil, on the right bank of the Ganges, had been completed during 1882-83, with the exception of a line of villages along the river: this year these villages were surveyed, and also the tract remaining for survey on the left bank, including the city of Benares. One hundred and nineteen square miles of the Maharaja of Benares' family domains lie in this part of the district, and it had been the intention to survey this area on the 2-inch scale only; but on the Maharaja undertaking to pay the cost of a cadastral survey, the Board of Revenue, North-West Provinces, sanctioned it, and this part of the family domains was included in the 16-inch survey of the district. One village of district Ballia lying on the right bank of the Ganges, consisting of a large tract of riverain land, has also been surveyed on the 16-inch scale: it had been included in the 4-inch survey of 1882-83, as part of district Shahabad within the jurisdiction of which it is situated, but as the revenue therefrom is paid in Ballia, the Settlement Officer required a field-by-field survey and *khasra*. In Basti, the survey broke ground at the south-west corner of the district in pargana Amorah: a good outturn of traversing was obtained, and two complete *tappas* (sub-divisions) and part of a third have been surveyed cadastrally.

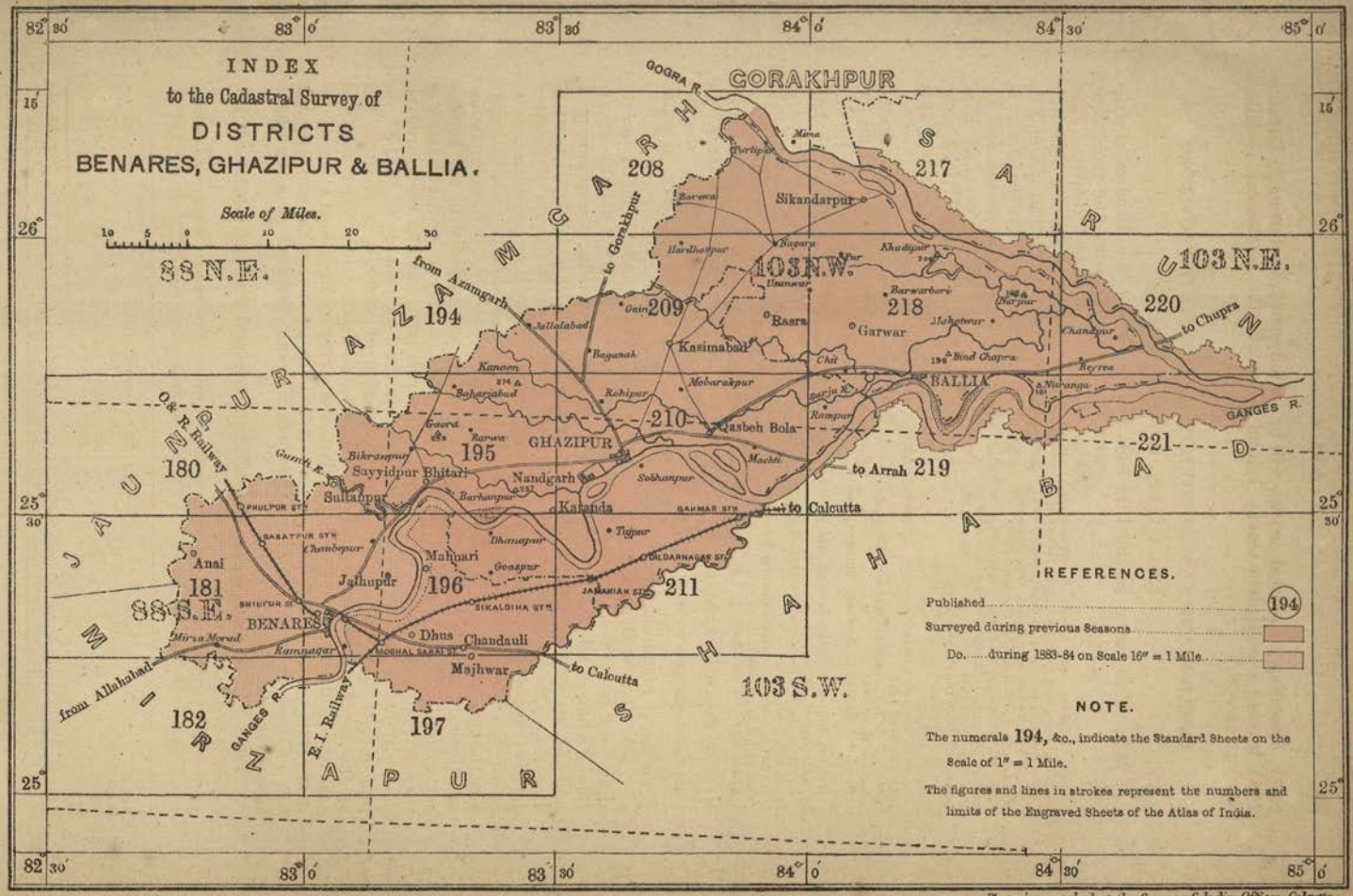
132. The separate areas surveyed, in the several districts mentioned, are shown in the following statement:—

DISTRICTS.	Scale of survey.	Number of villages.	Area in square miles.
Ballia	16 inches = 1 mile	1	11·41
Benares	Ditto ditto	1,420	611·09
Ditto	32 inches = 1 mile	44	10·98
Basti	16 inches = 1 mile	309	100·66
	Total ...	1,774	734·14

* Major Hutchinson again reports most favourably of Mr. Littlewood as follows:—"He is most judicious in his management of natives, is possessed of sound judgment, and has on all occasions displayed tact, patience, and perseverance in his work;" and adds that he is well fitted for the senior department. Mr. Dowman is said to have shown himself zealous and able in his work, and Mr. Smart to have sustained his reputation as a first class and zealous surveyor. Mr. Dunne has again conducted the duties of the revision camp with much credit. Messrs. Penrose and Ewing are reported to have worked well and given satisfaction.

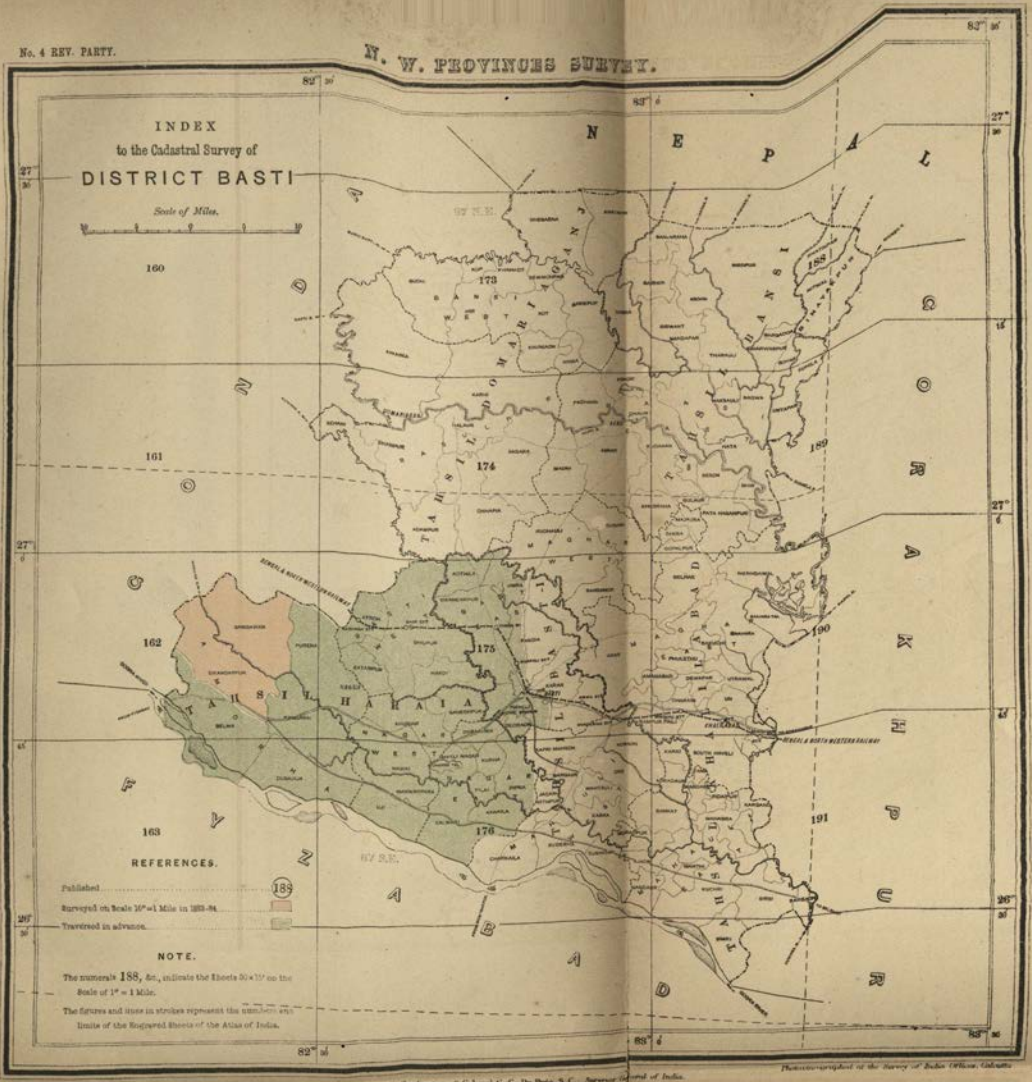
No. 4 REV. PARTY.

N. W. PROVINCES SURVEY.


INDEX
to the Cadastral Survey of
DISTRICTS
BENARES, GHAZIPUR & BALLIA.
Scale of Miles.
10 5 0 10 20 30
88 N.E.
88 S.E.
103 N.W.
103 N.E.
103 S.W.
GORAKHPUR
GOGRA R.
AZAMGARH
JAUNPUR
MIRZAPUR
BENARES
GHAZIPUR
BALLIA
GANGES R.
from Azamgarh
to Gorakhpur
to Chupra
to Arrah
to Calcutta
from Allahabad
E.I. Railway
O. & R. Railway
Sikandarpur
Kasimabad
Rasra
Garwar
Qasbeh Bola
Sayyidpur Bhitari
Nandgarh
Karanda
Sultanpur
Jalhupur
Mahuari
Anai
Dhus Chandauli
Majhwar
Ramnagar
Mirza Murad
Chaubepur
Tigur
Dhamepur
Geaspur
Barhanpur
Sobhanpur
Machli
Rohipur
Mubarakpur
Rampur
Jahatwar
Barwarbari
Khadipur
Nagara
Hardhanpur
Jallalabad
Kasaon
Baganah
Bind Chapra
Chandpur
Reyrea
Chandauli
Ghazipur
Ghazipur
Ghazipur

No. 4 REV. PARTY.

N. W. PROVINCES SURVEY.



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Survey of India Offices, Calcutta. February
1885

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133. The area surveyed on the 32-inch scale includes the city of Benares and suburbs, which was a very intricate and laborious piece of work. The number of fields surveyed is 872,144, the average size of which in the Benares district is 0·59 acre, and in Basti 0·34 acre.

134. The joint operation of survey and preparation of settlement records has been continued, as in the previous year, under the system known as the Benares system, the procedure of which was described in the Annual Report for 1882-83, pages 26-27, and appendix, page 88. The work has been carried on according to the hand-book of instructions compiled by Major Barron, as mentioned at page 27 of the same report, except that in the Basti district, where some changes were introduced in the division of labour which threw more work on the Survey Department. The results of this year's work have confirmed the favourable anticipations of greater expedition, and reduced cost under the combined system of survey and record-writing; but a complete statement of the actual expenditure on the Survey and revised Record-of-Rights of district Benares cannot be furnished until the work of the Settlement Department is finished.

135. Regarding the operations of the season, Major Cowan reports as follows:—

"The great difficulty in former seasons used to be the obstructiveness of the villagers in not giving the information and the free labour required; but this has been much diminished since the department began to write the *khasras* (field registers). This season the chief hindrances to the work have been:—

(1) The weakening of the establishment by the detachment sent to make a cadastral survey of the Dehra Dún and by the repeated drafts of inspectors and *amins* requisitioned for the same survey.

(2) The want of a sufficient area traversed in advance to admit of only one *amin* being told off to each *patwari's* circle, and in Basti the necessity for completing a defined limited area, which made it unavoidable that three and occasionally four *amins* should be kept at work within a *patwari's* circle.

(3) In most of the Maharaja of Benares' villages throughout the district his *kárandas* (agent) gave a great deal of trouble by not furnishing the labour required, and by making a point of contesting every claim to occupancy rights.

(4) The absence of boundary marks in the villages of the Maharaja's family domain and the consequent disputes and confusion. In other parts of the Benares district also the demarcation was imperfect and disputes numerous.

(5) The opposition of the Settlement Officer of Basti to the "new system" (of the Survey Department writing the records).

136. The work was, as usual, subjected to thorough test in all its branches. Correct bearings for the traverses were secured by observations for azimuth at 60 stations, of which 36 were on the main circuits at an average distance of seven miles apart. In the Benares district no stations of the Great Trigonometrical Survey fall within this year's area; but in Basti four principal stations were connected with, and the trigonometrical data has been used for correcting the traverses. The largest error of the chain measurements, shown by comparison of the direct distances between the stations with the distances given by the Trigonometrical Survey is — 3·04 feet per mile, and the least error is + 0·57 feet. The detail survey was tested by 2,018 linear miles of check survey, of which 674 miles were run by the European assistants and 1,344 miles by the native inspectors. Out of 872,144 fields that have been cadastrally surveyed, the *khasras* and *jamabandi* (rent roll) slips of 31,213 fields were tested on the spot by the Europeans, and those of 129,833 by the inspectors.

137. The theodolite stations have all been permanently marked; those in Ballia and Benares by pottery cylinders, where the total number of stations marked is 4,332, at an average cost of 5 annas per station. The stations in Basti, which number 6,716, have been marked by prism-shaped stones 2½ feet long with 5 inch sides. These stones were procured from Chunar and Mirzapur, and the cost of marking the stations therewith, after deducting the amount recoverable from land-owners, has averaged 9½ annas per station.

138. Three junior Civilians, Messrs. Oakeshott, Rice and Brereton, were attached to this party during a portion of the field season for instruction in surveying, in accordance with the orders of the Government of the North-West Provinces.

139. The mapping of the present season includes 1,310 sheets surveyed on the 16-inch scale, and 62 sheets on the 32-inch scale: none of these have yet been sent to Calcutta to be printed, as until the work of the Settlement Department, including the final attestation of the records, is finished, small alterations and corrections are frequently required. The smaller scale maps consist of 6 sections on the 2-inch scale (for reduction by photography to 1-inch) of district Benares, and a compilation of the general maps on the scale of the Atlas of India of districts Ballia and Benares has also been made. In the original 4-inch sheets of the tracts lying along the banks of the Ganges and Gogra rivers, which were kept back for reasons mentioned in paragraph 146 of the Annual Report, the village boundaries according to the former surveys of 1842-44 and 1863-64 have been inserted: thus a direct comparison has been provided on one record of the boundaries as they existed at the dates of the several surveys.

140. Valuable assistance was rendered to the party by Mr. F. W. Porter, the Settlement Officer of Benares, who facilitated to the utmost the work both of survey and of the *khasra*-writing.

141. The recess office of the party was inspected at Naini Tal during October 1883 by the Deputy Surveyor-General in charge Revenue Branch. He considers that Major Cowan deserves credit for the state of efficiency in which he found all branches of his large establishment, and for the manner in which his establishment carries out the new duties connected with writing the village *khasras*.*

CHHATTISGARH DIVISION, RAIPUR DISTRICT, CENTRAL PROVINCES.

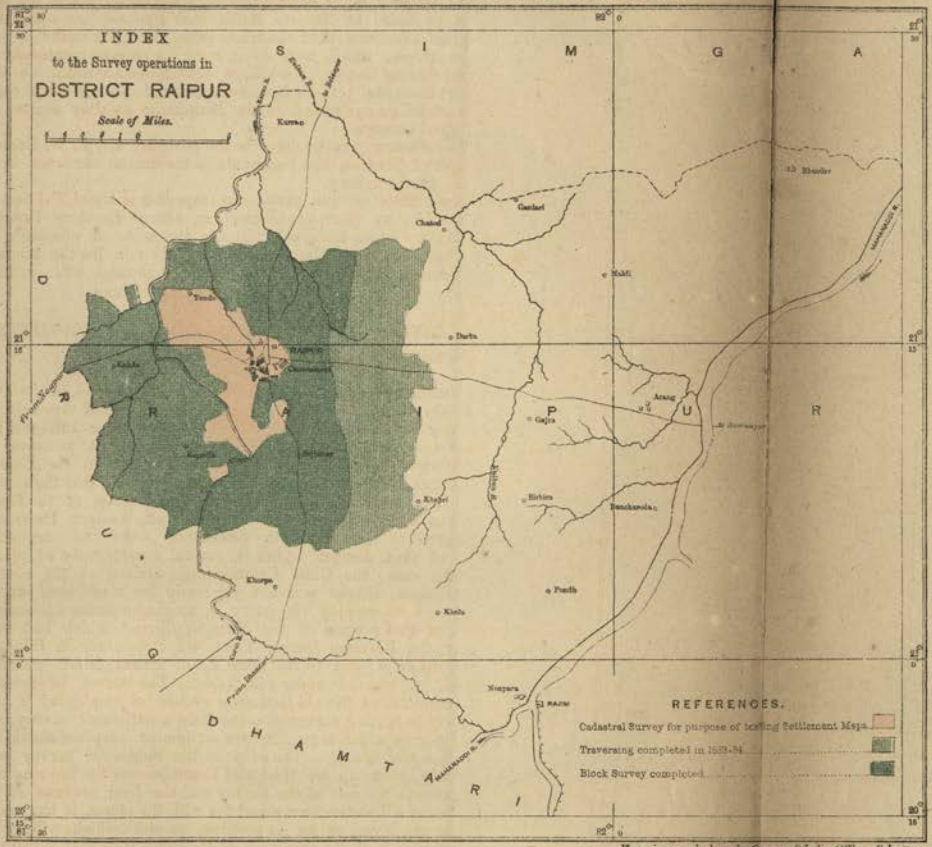
(DETACHMENT FROM No. 3 PARTY, REVENUE BRANCH.)

142. This detachment was deputed to the Central Provinces in October 1883, under the orders of the Government of India, Revenue and Agricultural Department, in their letter No. 394S, dated 11th September 1883, for the primary purpose of conveying practical instruction in surveying to *patwaris*.

143. The history of the employment of a survey party in the Central Provinces is somewhat peculiar. It was originally proposed that the survey party, which had been engaged on the topographical survey of the Doab, between the Ganges and Jumna rivers in the North-Western Provinces, should be transferred to Sambalpur in November 1883, to commence a cadastral survey of that district. After a careful consideration of all the circumstances of the case, the Chief Commissioner arrived at the conclusion that the Sambalpur district was not yet ready for a cadastral survey, and he then proposed to employ the party in making a mouzawar survey, on the 4-inch scale, of that portion of the Bilaspur district which had been left unsurveyed by the Revenue Survey Party, when formerly in Bilaspur. The area of this portion is said to be over 2,000 square miles, considerably more that half of which is under cultivation. The Survey Department deprecated the resuscitation of the old mouzawar system of employing a professional survey party to make a survey as a check on a settlement survey, and advocated that any survey which is required for settlement purposes should be undertaken by professional agency. The idea of the mouzawar survey was, however, immediately given up by the Chief Commissioner for the reason of the disproportion between the cost of the survey and the land revenue of the district. Finally, two small parties were asked for with the object, it was understood, of their being employed, as far as possible, on work which will be of utility to the administration of the provinces, at the same time that advantage is taken of them as a means of instructing *patwaris* in anticipation of the general survey of the district. The method on which such survey should eventually be conducted was left open for further discussion.

* Major Cowan reports very highly of the cordial and efficient assistance given by Mr. G. H. Cooke, officiating Deputy Superintendent, and of the services rendered by Messrs. Hanby and Price, who had charge of cadastral camps and who spared no labour or pains to secure a large outturn of reliable work: Mr. Price's work includes the Benares city survey. The other European assistants are also very favourably reported on, and the following members of the native establishment are mentioned as having worked conspicuously well:—Computers, Lalmohan Gangopadhya, Shew Narain, and Kanaya Lal; Sub-Surveyors, Jamaludin and Bhawani Parshad; Draftsmen, Asjad Ali and Syadudin Ahmad; English writer, Ibu Hasan.

CENTRAL PROVINCES SURVEY.



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Survey of India Offices, Calcutta, February.

1885

144. With the above object in view it was arranged that a strong detachment, in lieu of the two small parties, should be organized for the Chhattisgarh division for the field season of 1883-84, and that Major E. H. Steel, Deputy Superintendent of Survey, should superintend the professional work of the detachment, and be deputed to Nagpur to confer with the Chief Commissioner, Central Provinces, on the method of survey which would best suit the requirements of the province. Major Steel arrived at Nagpur on 20th October 1883, and after considerable discussion with the Revenue Secretary, and a clear expression of opinion on the part of the Chief Commissioner that the revenues of the provinces were not sufficient to bear the cost of a professional cadastral survey, it was decided—(1) to adopt the "field block" system for the general survey of the district, *i.e.*, the skeleton survey of the boundaries of villages, together with those of moderately sized blocks of fields, the interior fields of which are afterwards to be filled in by *patwaris*, who should also write the Records-of-Rights; the supervision of the Survey Department to end with the survey of the field blocks; further, that the Survey Department should supply maps showing the boundaries of villages and of the field blocks, and furnish the area of each block; (2) to make a cadastral survey of a certain number of villages in order to test the accuracy of the former settlement maps; (3) to organize a survey class for the instruction of covenanted civilian officers, native officials and *patwaris*; and (4) that the above operations should be confined to the Raipur district.

145. A detachment therefore of the strength as per margin was withdrawn from No. 3, Revenue Party, and placed under the direct charge of Mr. P. A. G. Cowley, Surveyor, 1st grade, who received definite orders on 15th November 1883 for the work required. The field operations were continued till 20th April 1884, when the party proceeded to Nagpur for recess.

Personnel.

Mr. P. A. G. Cowley, Surveyor, 1st grade, in charge.
Mr. G C. Swincy, Assistant Surveyor, 1st grade.
6 Sub-Surveyors and others.

Temporary Establishment.

25 Field Surveyors and others.

146. The area surveyed is given in the following statement :—

Pargana.	Description of Survey. Scale 16 inches=1 mile.	Number of villages.	Number of blocks.	Area in square miles.
Raipur	Boundary traverse in advance ...	152	584	275
	Boundaries of field blocks	94	1,133	200
	Cadastral survey	22	130	31
	Total ...	268	1,847	506

A minute survey of the city and civil station of Raipur was also made at the request of the Chief Commissioner.

147. The village circuits were traversed and then sub-divided into blocks varying from 60 to 80 acres; the field surveyors surveyed the boundaries of the fields contiguous to the lines forming these blocks. The angular work of the traverses has been checked in the usual way by a number of observed azimuths, and the chain measurements have closed well, but no trigonometrical stations were available to connect them with for the purpose of affording a rigorous test of their accuracy. The survey of the "field blocks" has been tested by 275 linear miles of check survey run by the inspectors and sub-surveyors, and as a further proof on these tests the European Assistant has carried a check line through very nearly every village that has been cadastrally surveyed.

148. The Deputy Surveyor-General strongly protested against the adoption of this "field block" system for the general survey of the Central Provinces for reasons which may be here recapitulated. By this method two agencies for the construction of the final maps must be employed. The faults of the principle of such a system must generally be allowed, for under it the professional surveyors, who are the most competent to turn out a complete map, are required to leave part of the work undone, though passing over the ground and taking measurements for their share of the undertaking, which requires to be only slightly supplemented to permit of a complete map

being constructed, and such a system can only be justified by a large saving of expenditure which may accrue through the employment of a low-paid agency to carry out the subsequent measurements. This is a point, however, which yet remains to be determined, and even if the result is in its favour, the accuracy of the maps must remain an undeterminate quantity. Other disadvantages follow from the rendering of an incomplete map. (1) The maps as they stand are of no practical value for assessment purposes, and it would be hardly advisable to print them in their incomplete state, while it would be obviously inexpedient to hand over the original maps to village officials to be retained until the measurements could be completed. (2) The professional area statements are of an incomplete character, which would have to be discarded when the final statement to correspond with the final maps could be worked out. (3) The first set or professional surveyors cannot be employed in writing the *khasra* or field register, which it has been proved by practical experience in the North-West Provinces surveys they can do with very great advantage as to economy, accuracy, and rapidity of execution of the joint operations of survey and settlement. The survey and settlement of a tahsil in Gorakhpur worked under this combined system has lately been completed in 18 months—a work which under the previous ordinary method would have occupied from four to six years.

149. The system under which the survey of the Hissar district, in the Punjab, has been carried out for subsequent cadastral survey by local agency is one of an entirely different character, as the professional survey there has been confined to the determination of the co-ordinate distances of points on the boundaries of villages and in the interior of village lands which provide for the projection of purely skeleton maps only, on which all the details of the fields and other features will afterwards be filled in by one establishment of local surveyors. This system is at least professional, in so far that it avoids the mixing up of the work of two sets of surveyors in mapping the fields, but it can hardly be considered a wise proposal to restrict the work of a staff of professional surveyors under highly-trained officers to the preparation of a mere skeleton map, while the really important part of a settlement survey, viz. the mapping of the fields, the determination of the areas, and the writing of the Record-of-Rights are left to be undertaken by local surveyors under local supervision. Such a system can never be attempted, unless the thorough training of the local surveyors has been fully provided for.

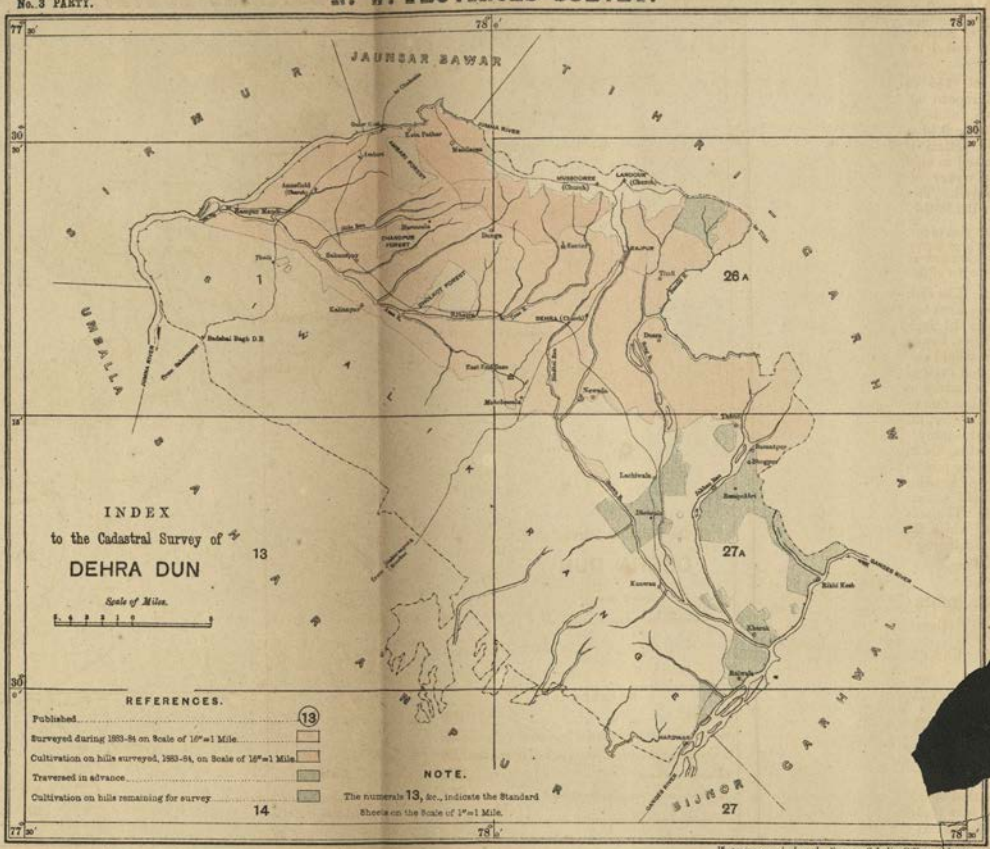
150. The radical fault of both these systems lies, *firstly*, on the assumption that numerical data and a series of lines on a sheet of paper are an efficient substitute for the control exercised by highly-trained European surveyors; and *secondly*, in the supposition that a correct map or index is the sole aim of a cadastral survey, instead of an accurate Record-of-Rights of the people and the conditions of the land. The value of the Survey Department undertaking the writing of the records is now recognized by the fact of the European supervision, which they are able to give in testing the entries. In the "field block" system of the Central Provinces the writing of the Records is to be relegated to the *patwari*, who is usually appointed by the landholder, and who, as cheapness is the essential feature of the system, will be but little, if at all, under European control.

151. To return to the operations of the party, it had been arranged that the demarcation of the field blocks should be marked out in advance by the Settlement Department, but Mr. Cowley found on commencing operations that this had not been effected, as the civil authorities were unprepared for a survey. The Boundary Surveyors therefore laid out their own blocks at first, and it was subsequently found that by this arrangement the work progressed much faster, and as it also saved the cost of an expensive demarcating establishment, the civil authorities gladly acquiesced in its continuance. The permanent demarcation of the boundaries was excellent, and all theodolite stations, excepting those of a few villages surveyed at the commencement, are on stone boundary pillars which have been marked by a cross or circle cut into the stone. The interior or field block stations have also been marked by stones in a similar manner.

152. The principal duty of the European officers of the detachment has, however, consisted in the instruction of *patwaris* in surveying, as the Chief

No. 3 PARTY.

N. W. PROVINCES SURVEY.



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1885

Photozincographed at the Survey of India Office, Calcutta.

Commissioner requested that Mr. Cowley should devote as much of his time as possible to this work, with the view of utilizing this *patwari* agency in the general survey of the province. Regarding this work Major Steel reports:—

"A survey class was opened by Mr. Cowley, who worked on a very good system, and when his material was promising, as in the case of the European officers, the results are encouraging; but the amount of knowledge of surveying, and the thousand and one details which go to make up the acquirements of a good executive officer of any grade can hardly be gained in a fortnight or three weeks, which was the average time spent in the survey class."

In all 185 candidates passed the examination: of this number, six were European officers, five were Extra Assistant Commissioners, 78 were tahsildars, naibs, &c., and 96 were *patwaris*. Of these *patwaris*, eight were employed as field surveyors in the regular survey, in order to give them a good practical training for the posts of *patwari* inspectors. Their work has been classed as equivalent to that of slow second class *amins*. The value of the working power of the remaining 88 *patwaris* has not been tested and remains to be proved. The average cost of the survey instruction of each student is given at Rs. 30-2-7. Major Steel remarks:—

"This plan of teaching *patwaris* does not seem a very promising method of introducing a better style of surveying into the Central Provinces. The men in many instances are too old to learn new ways, and are wedded to methods and customs which cannot be swept away by the *fiat* of the legislature, or by the exaction of heavy penalties."

153. The cadastral maps of four of the villages of which a re-survey was made, have been reduced to the scale of the old settlement survey, which was about 12 inches to the mile, to enable a comparison to be instituted. The villages, however, which have been selected are small ones, the periphery of which should easily have been accurately delineated, but the old survey, when tested even under these favourable circumstances, was found inaccurate both in boundary and in the interior detail. Besides these differences, which are doubtless due to faulty survey, there are large differences in the cultivation, which, however, may have so altered and increased since the time of the settlement survey. Of the value of the old survey as an index to the records, no estimate could be formed, as it was found impracticable to write a new *khasra*, owing to the pre-occupation of Mr. Cowley in instructional duties and to the difficulty of securing the necessary attendance of the parties concerned, due to the fact of a settlement survey not being in progress.

154. The season's outturn of 16-inch survey has been mapped on 222 sheets, of which 42 sheets appertain to the cadastral survey of the tested villages, including the city and civil station of Raipur, and 180 sheets to the field block survey.*

DEHRA DUN DISTRICT, NORTH-WEST PROVINCES.

(DETACHMENT FROM No. 4 PARTY, REVENUE BRANCH.)

155. Under the orders of the Government of India in the Revenue and Agricultural Department No. 387S, dated 5th September 1883, a detachment, was withdrawn from No. 4 Revenue Party, working in the Benares district, to undertake a cadastral survey of the cultivated lands in the Dehra Dún district. This department was asked to arrange for the survey of about 80,000 acres (125 square miles) in that district in one season, and estimates and arrangements for establishment were made accordingly. A detachment of the strength given in the margin was placed in charge of Mr. W. A. Wilson, an experienced Revenue Surveyor, to carry out the survey under the general superintendence of Major W. Barron, the officer then in charge of No. 4 Party. The arrangement for

Personnel.

Mr. W. A. Wilson, Surveyor, 2nd grade, in charge.
„ E. F. Berkeley, Assistant Surveyor, 3rd grade.
6 Sub-surveyors and others.

Temporary Establishment.

80 Field surveyors and others.

* The Deputy Superintendent, Major Steel, testifies to the zeal and ability with which Mr. Cowley has conducted the operations, and to his really able method of imparting instruction. The services of Mr. Swiney are highly spoken of, and the sub-surveyors have all worked well.

the superintendence was subsequently changed, and this detachment, together with two others employed in Rajputana and the Central Provinces, was placed under Major E. H. Steel, Deputy Superintendent, 4th grade, on 2nd November 1883, and the operations have been executed under that officer's supervision from that date.

156. Owing to the late date on which the orders relating to the constitution of the detachment was received, the preparations were necessarily much hurried. Mr. Wilson arrived in Dehra on 12th October, and commenced the preliminary traverse survey on the 23rd idem. The field operations were continued in the Dún until the 25th May, and in the hills until the 15th September 1884.

157. It was soon discovered that the area for survey had been much underestimated, for though the area actually under cultivation did not probably exceed the estimated amount, yet the lands under cultivation were so situated, and so intermixed with jungle, that in mapping the cultivation the whole village in the majority of cases required to be surveyed. Moreover, in December 1883, the cultivation in the higher hills, which had been altogether omitted from the original project, was added to the work to be undertaken by the detachment. Thus the area to be dealt with cadastrally was greatly increased, and necessitated an increase in the strength and equipment of the detachment, which, however, owing to the reduced state of the department, could only be done gradually and towards the end of the field season, when officers and men could be spared from the various other field parties. During April and May the strength of the detachment stood as follows:—Eight European surveyors and assistant surveyors, 10 sub-surveyors, 130 field surveyors and others.

158. The total area that has been surveyed cadastrally on the 16-inch scale is 268·59 square miles; in addition preparatory traverse work has been extended over 97 square miles in anticipation of the cadastral survey in 1884-85. The number of fields surveyed on the cadastral area is 98,687, having an average size of 0·78 of an acre, the cultivated area of actual fields being comprised in about 120 square miles.

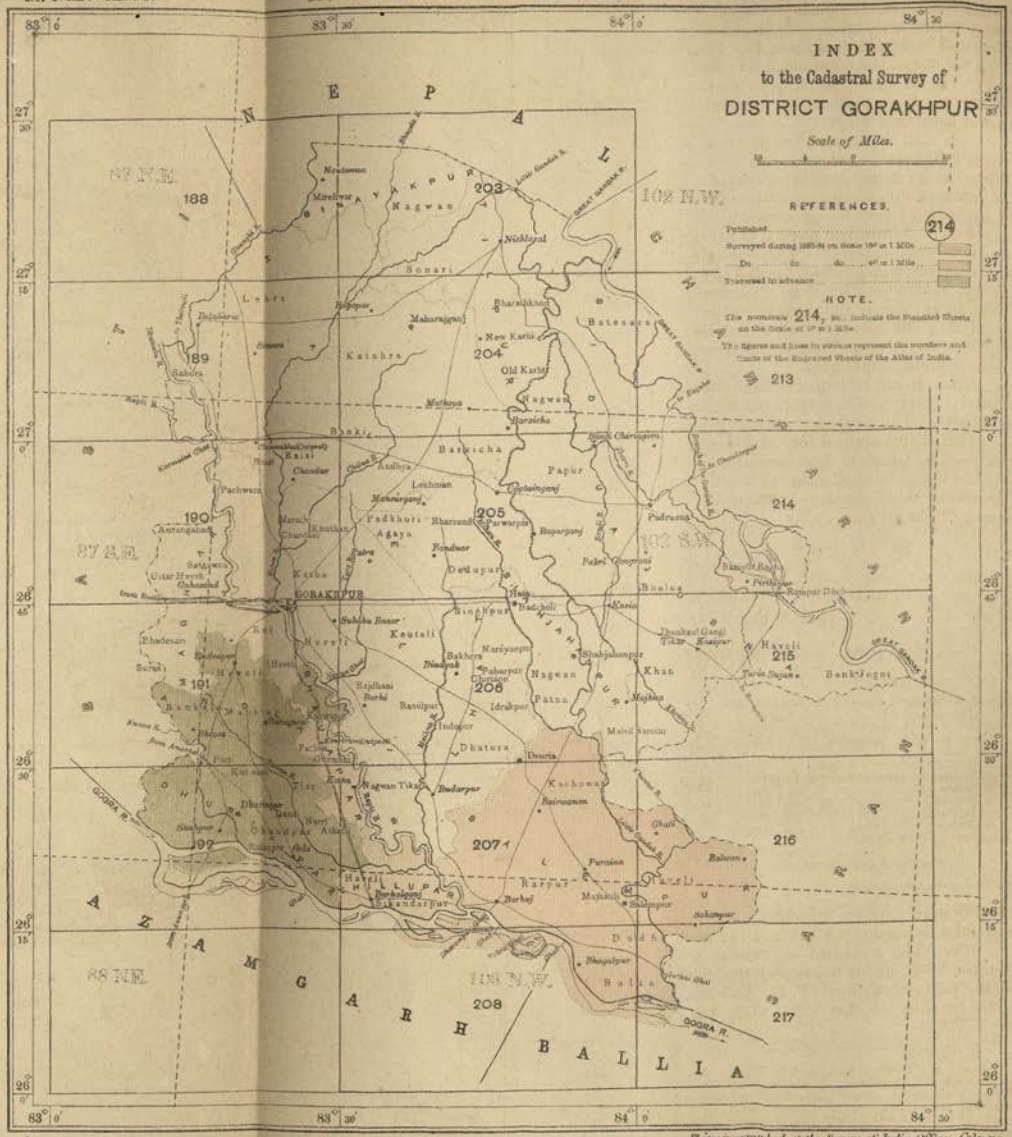
159. The cadastral work has been carried out under the Benares system, in which the field register (*khasra*) is written up in *Urdu* by the *amin* in the field, simultaneously with the preparation of the map, while the village *patwari* prepares a similar record in *Nagri*, writing also, concurrently, in the *jamabandi* slips the numbers of the fields as they are surveyed. The *patwari's* copy of the *khasra* and the *jamabandi* slips are then sent on to the Settlement Office. On the completion of the map, the computation of field areas is carried out and entered in the *amin's* copy of the *khasra*, which is then made over to the Settlement Department, together with two traces of the village map. The field measurements were plotted directly on the board plans, without recording them in field books. Out of 316 villages that were traversed, 279 were completed in detail cadastrally, and in the remainder only the cultivation, together with any contiguous features was surveyed, the topographical details beyond the cultivation being entered on the plans by pentagraph from the 4-inch scale maps of the Dún, the survey of which was executed in 1873-76.

160. The work of the field surveyors has been thoroughly tested by check lines aggregating 319 miles in length, carried out by the native inspectors, and by frequent inspections made by the Deputy Superintendent and European officers. Azimuth observations were taken at 32 stations as a check on the angular work of the traverses, while the numerous points which had been determined trigonometrically by the previous 4-inch survey furnished an admirable check on the chain measurements, which, owing to the rugged nature of the country, were prosecuted under a great disadvantage.

The villages, numbering 44, on the higher hills, could not however be surveyed in the usual manner with theodolite and chain; and in these the cultivation alone has been surveyed, the boundaries and other topographical features being transferred from the maps of the previous survey. The survey of this hill cultivation is stated to have been an exceedingly arduous and difficult task, but it was much facilitated by the use of the trigonometrical points of the former survey, from which additional stations were interpolated into the cultivated areas, and supplied the frame-work for the detail survey of the fields. Three assistants—Messrs. Hamer, Coxen, and Lilley of the Topographical Branch—were deputed in the latter half of March to assist in this hill work.

No. 5 REV. PARTY.

N. W. PROVINCES SURVEY.


INDEX
to the Cadastral Survey of
DISTRICT GORAKHPUR
Scale of Miles.
REFERENCES.
Published
Surveyed during 1865-66 on Scale 16" or 1 Mile
Do do do 4" or 1 Mile
Traversed in advance
214
NOTE.
The numerals 214, &c., indicate the Standard Sheets on the Scale of 16" or 1 Mile.
The figures and lines in circles represent the numbers and limits of the Engraved Sheets of the Atlas of India.
NEPAL
GORAKHPUR
BASTI
AZAMGARH
BALLIA
GOGRA R.
GANGES R.
Nagwan
Nichlaul
Bharaikhan
Batesara
Maharajganj
New Karhi
Old Karhi
Kaishra
Barhicha
Papur
Padrauna
Deoraipur
Kautali
Nagwan
Patna
Dhaturia
Barhaj
Balua
Rasulpur
Idrakpur
Shahjahanpur
Khan
Bansgaon
Haveli
Bankatgunj
Rajapur Dih
Purainia
Baleoa
Bhagalpur
Dodh
Sukhpur
Sonauri
Lakra
Belaharia
Sahora
Sonora
Pachwara
Aurangabad
Sadhawa
Uttar Hardia
Gokulchak
Rhadesan
Surai
Haveli
Ajgara
Kasba
Padkhori
Bharsand
Agaya
Bandaur
Leichman
Mahasinganj
Tarkulsinganj
Bansi
Chandan
Chandauli
Ratauli
Marach
Chauraha
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Ratauli
Marach
Chauraha
Bansi

161. The country operated in during the season is exceedingly difficult for cadastral operations, and presents ground of very varied character from the flat cultivated land in portions of the Western Dún to the crest of the Mussooree range, which rises to a height of 5,000 feet above the valley. The low spurs and broken ground about the foot of the Himalayas, being covered with thick *sál* forest and intersected by deep ravines, gave an infinity of labour and trouble in surveying. Major Steel reports that all the European officers and many of the native establishment were laid up with fever and dysentery during April and May.

162. All the tri-junction points of villages, as well as many other points on their boundaries, were found marked with masonry pillars, which were utilized as far as practicable for traverse stations. In addition to these boundary marks, 3,000 theodolite stations have been permanently marked by stones 15 inches × 6 inches being embedded in the ground. The numerical records contain the co-ordinates of each of these points and the requisite data for finding them when required. There are also the trigonometrical stations of the 4-inch survey which were marked by masonry pillars at the time of that survey, so that the district is well supplied throughout with permanent marks, which at any future time will be available for reference.

163. The area surveyed cadastrally has been mapped on 525 sheets, and duplicate traces of all these sheets, comprising 348 villages, have been supplied to the settlement officer.

164. It will be gathered from this report that the Dehra Dún survey has proved a very much larger undertaking than this department was led to anticipate. The area for survey proves to be three times greater than the original area applied for, and notwithstanding that the establishment was increased by transfers from several other parties, and the work prolonged far into the hot weather, the survey could not be completed. An area of about 100 square miles remains unsurveyed, which the detachment will complete during the current season.*

GORAKHPUR DISTRICT, NORTH-WEST PROVINCES.
(No. 5 Party, Revenue Branch.)

165. This party, having completed its operations in the Mirzapur district during the previous year, was transferred to the Gorakhpur district, in accordance with the Resolution of the Government of the North-West Provinces, communicated in their letter No. 961, dated 17th April 1883, together with the decisions, that the system of survey and record writing to be adopted in Gorakhpur, should be that followed in Benares, where the settlement establishment work along with the survey establishment; and in addition, that the classification of soils should be left to the Survey Department. The Benares system of survey and preparation of settlement records was described in paragraphs 141 and 142 of the last annual report.

Personnel.

Major J. E. Sandeman, Deputy Superintendent, 3rd grade, in charge.
Lieutenant F. B. Longe, R.E., Assistant Superintendent, 1st grade, joined on 14th December 1883.
Mr. E. G. Little, Surveyor, 3rd grade.
„ T. F. Freeman, Assistant Surveyor, 1st grade.
„ T. Shaw, ditto 1st do.
„ J. Murphy, ditto 1st do.
„ G. D. Smart, ditto 3rd do.
„ N. Bedford, ditto 3rd do.
14 Sub-surveyors and others.

Temporary Establishment.

250 Field surveyors and others.

166. The cadastral operations were commenced in the last week of October 1883, under the superintendence of Major Sandeman, who took charge of the party on Colonel F. C. Anderson's retirement; and they were closed in the middle of May 1884, when the party returned to recess quarters at Naini Tal.

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* Major Steel reports very highly of Mr. Wilson's administrative powers and of his knowledge of cadastral work, and states that with a very inadequate establishment he has prosecuted the survey of a most difficult piece of ground with exceptional vigour. Messrs. Hamer, Coxen and Lilley are said to have performed their duties zealously and well, and were of much assistance in the hill survey; Mr. Hamer being specially praised.

Mr. Wilson commends Mr. E. F. Berkeley's services, and says that he gives every promise of becoming a first-class surveyor.

167. A survey has been made on the 4-inch scale of the low-lying villages opposite to district Gorakhpur on the right bank of the Gogra river in districts Ballia and Azamgarh. The boundaries of the villages in Ballia were transferred from the maps of the recent survey of 1874-76, in accordance with the views of the Collector of that district, but in Azamgarh, where the last professional survey was made so far back as 1836, the village boundaries have been resurveyed.

168. The separate areas on the different scales, and in the different districts which have been under survey, are given in the following table :—

Districts.	Tahsil.	Description and scale of survey.	Number of villages.	Area in square miles.
Gorakhpur	Deoria ...	Cadastral; 16 inches=1 mile.	1,455	586·81
Ditto	Bansgaon ...	Ditto ...	428	157·50
Total of Cadastral Survey ...	.....	.....	1,883	744·31
Ballia Azamgarh }	.....	Mouzawar; 4 inches=1 mile.	31	49·00
Total of Mouzawar Survey ...	.....	.....	31	49·00

An overlap of 16·50 square miles has been surveyed in the Sarun district on the 2-inch scale. In the cadastral area 891,996 fields have been surveyed, thus giving an average area for each field of 0·53 of an acre. In addition to the above outturn, preliminary traversing has been extended in advance over an area of 401 square miles for cadastral survey next season.

169. Several important changes on the method adopted in Benares have been introduced in the Gorakhpur work, the principal ones being—

(1) The Survey Department completes the records and is responsible for their accuracy.

(2) The attestation is made after the completed records have been lodged.

The details of the procedure and of the division of labour between the Survey and Settlement Departments are fully described in the following papers, which are given at pages CXXV to CXXIX of the appendix, viz. a joint note drawn up by Mr. J. D. LaTouche, Settlement Officer, and Major Sandeman, Deputy Superintendent of Survey, dated 18th January 1884; a note by Major Sandeman, dated 8th February 1884; and a report No. $\frac{72}{1}$, dated 11th February 1884, from the Settlement Officer to the Commissioner of the Benares Division. The great defect of the Benares system is that attestation of the records has to be done before the areas are entered. This has been remedied in the Gorakhpur system. The basis of this system is that the Survey Officer should furnish along with the map a correct record of all undisputed facts of ownership and tenancy, together with a complete list of all disputes, and should classify the soils. The Revenue Officer fills up the dispute list and checks the soil classification: the attestation of the records and the assessment of revenue is his work also.

170. The great advantage claimed for this system over the Benares one is that it permits of the attestation of the records being completed during the season of survey on records which give the areas, and that the assessment follows immediately afterwards; further, that the record-writing and soil classification is under the same strict supervision as the survey. There is a great check on bribery and corruption from the fact that the *patwari* prepares a duplicate record on the spot for every field, and a duplicate of the dispute list. Under this system the areas are all entered in the survey office under European supervision, and their classification for the Settlement Officer multiplies the checks over them to such an extent that the statistics should be as faultless as it is possible to make them.

SOIL MAP
OF
TEHSIL DEORIA
DISTRICT GORAKHPUR
Surveyed in Season 1883-84.

Scale 4 Miles = 1 Inch.

Lithographed at the Survey Office Calcutta, March 1885.

171. The Board of Revenue, North-Western Provinces, have acknowledged the improvements made by Mr LaTouche and Major Sandeman on the Benares system, and admit the success of the present combined system of survey and settlement. The Board's letter No. $\frac{136}{IX.\ 19}$, dated 7th March 1884, on this subject will be found at page CXXIX of the appendix.

172. With regard to the classification of the natural soils, which has been undertaken for the first time by the Survey Department, Major Sandeman reports as follows:—

"The natural soils are easy of recognition. They are, *doras* (sand and clay), *matyar* (clay), *balua* (sand), *bhát* (cretaceous), and *kachhár* (new alluvium). The responsibility for accuracy with regard to the above rests entirely with the Survey Department. These soils, however, are again divided into conventional tracts, first, *goind* or home lands, which are easily manured; next *miyana* or *manjhar*, or the middle lands; and third, *palo*, or outlying lands. These classes are entered in the same column as the natural soil by enquiry from the *patwari*, and every endeavour is made to arrive at the class for each field as it is locally known, but as these divisions affect rent, the Settlement Officer takes the precaution of having the survey trace, which shows the survey demarcation of soil tracts, examined and corrected according to the opinion of a special soil *munsarim*. The final examination of the double demarcation is done by the Settlement Officer, who is thus greatly helped by having before him the expert's demarcation and that from local enquiry; the final decision as to a safe and just line resting with himself."

A soil map, on a small scale, of the Deoria tahsil is attached, as an illustration of what has been done.

173. The statistics for assessment purposes are also compiled in the survey office. The Settlement Officer in deciding to entrust this work to the survey department, wrote:—

"The Survey can do this work much better than the Settlement Department, and much cheaper. They have a staff of eight European assistants to check the work, and their men are much more expert at figures than any whom I could employ."

174. These statistics comprise the soils, irrigated and dry; the details of soils under cultivation; the tenures of the holdings; the culturable and barren areas; the areas under different crops; the cultivators, showing the numbers in each caste and the areas cultivated by each caste; and all agricultural statistics with respect to wells, ploughs, cattle, &c. The duties and responsibilities of the survey officers by these arrangements have been very materially increased; but there is every reason to hope that there will be a corresponding increase to the accuracy of the records and to the gain of the Government and the people. The old cost rate for field survey unaccompanied by records used to be 4 annas an acre. The rate for the work done by Major Sandeman in Gorakhpur, which comprises survey, soil maps, and completed records ready for attestation and assessment, is only 4 annas and 6 pies an acre. The cost of the settlement for the corresponding area is not yet known, so the rate for the complete operations cannot be given; but as the Survey Department (with the slight addition to its old rate of 6 pies an acre) has done such a large extent of the ordinary work of the Settlement Department, the rate for the latter must be considerably reduced, and a very large saving is expected to result by the cordial interworking of the two departments.

175. Major Sandeman reports:—

"We met with several difficulties this first season, many of which will not recur. We were all new to the work; the establishment was not a good one; the instrumental equipment was defective; the area that was prepared in advance during the previous season (owing to the orders for the Gorakhpur Survey having been issued late) was so small that often two or more *amins* were crowded into one *patwari's* circle; the Deputy Collectors and their subordinates were at first not favourably disposed towards the new order of things; and finally, we could not hit upon a final plan of operations till we had gained some experience. To add to the difficulties, the tenures were nearly all *pattidari* (held in severalty by proprietors), which enormously increases the work both in field and office, and the cultivators' fields were small, averaging 0·53 of an acre only."

Further extracts from Major Sandeman's narrative report, giving details of his operations, will be found at page XXI of the appendix.

176. The field survey has been tested by 1,359 linear miles of check surveys, of which 181 miles were measured by European officers and 1,178 by native inspectors. To check the angular work of the traverses, azimuth

observations were taken at 65 stations. The traverses have been connected with five trigonometrical stations, and the result of the comparison gives an average error of 1·84 feet per mile in the chained distances. To test the records, 5 per cent. were verified by European assistants and 20 per cent. by *munsarims*. The Deputy Superintendent personally tested a small percentage, and in addition there was the check of the Settlement Officer and his Deputy Collector, one of whom was attached to each Survey Camp.

177. All the theodolite traverse stations have been marked by stone prisms, 2 feet 9 inches long, of which 6,163 have been embedded during the season at the rate of 7 per square mile, and wherever practicable the stations have been fixed on the actual boundaries of villages, so that ample permanent marks have been provided for any future additions to the present survey, as well as for the identification of the boundaries. The cost rate of this permanent marking, after deducting recoveries from land-owners for stones embedded actually on boundaries, is Rs. 2-6-8 per square mile.

178. Regarding the boundaries of the Gorakhpur district, Major Sandeman reports that the survey of the boundary with the Sarun district has been made according to possession, but that a territorial boundary has still to be decided by the Governments of the North-West Provinces and of Bengal, and that some boundary disputes remain unsettled. Another question awaiting decision is the boundary on the Gogra river with the districts of Azamgarh and Ballia. On this subject Major Sandeman writes:—

"In the last survey maps of Ballia, those of 1877, this boundary is shown in mid-channel, whereas by law it should be the deep stream. Pending the settlement of the question, and by the Settlement Officer's directions, the mid-channel has been adopted as the limit of the villages on the Gorakhpur side, and the deep-stream boundary is also shown on the maps in dots.

"A great number of boundary disputes arose between villages within the district: the direct cause of these is very evident, for the old settlement maps were found to be very defective and to overlap each other."

The Settlement Officer, to remedy this difficulty in future, has advised that accurate surveys, where they do not exist, should be made in all cases of disputed boundaries, and his letter on the subject, No. $\frac{65}{1.C.S.}$, dated 15th November 1884, is given at page CXXIX of the appendix.

179. Two junior Civilians, Messrs. Guthrie and Saunders, were attached to this party for three months, for instruction in surveying, under the orders of the Government. This duty was undertaken by the Deputy Superintendent, as no assistant was available.

180. From the experience that has been gained by the work of this season, certain alterations in the division of labour and in other matters of procedure have been made for the working of the two departments next season, which, it is expected, will tend to improve the results. The important changes, as far as the Survey Department is concerned, are—

(1) That disputed entries are to be made in all the records in red ink, on the responsibility of the *patwari*, instead of being left blank.

(2) The demarcation of soils, both natural and conventional, is to be made over entirely to the Survey.

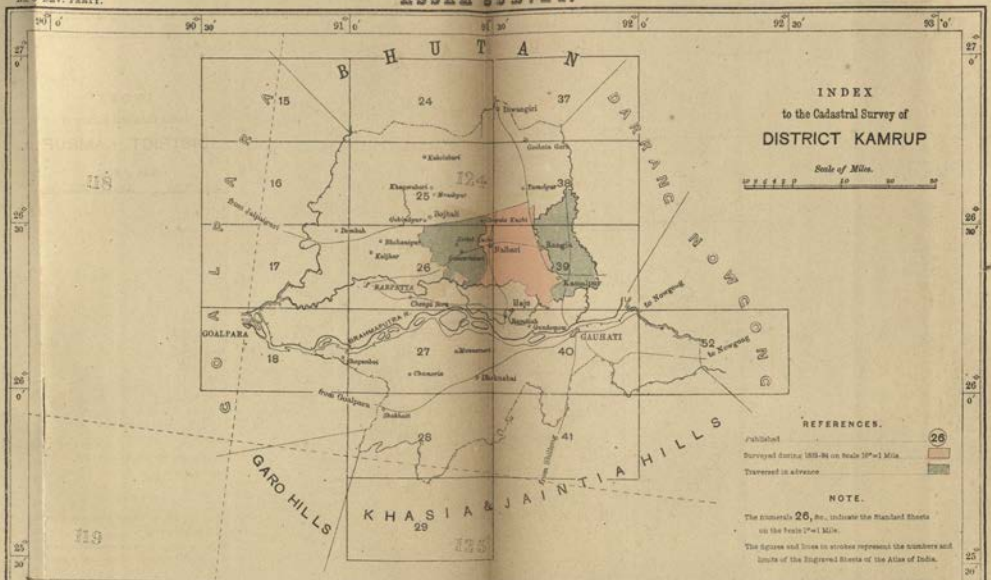
(3) The papers now will not be sent backwards and forwards between the survey and settlement officials.

The revised rules for the working of the Survey and Settlement in Gorakhpur during 1884-85 are printed in full at pages CXXXI to CXXXIII of the appendix.

181. The Cadastral Survey in Gorakhpur has been mapped on 1,500 sheets on the 16-inch scale. A separate series of standard sheets of the 4-inch survey, comprising the area between the permanent line of village boundaries on both banks of the Gogra river, is in course of preparation. The compilation of the 2-inch topographical maps by reduction from cadastral maps will not in future be undertaken by the field parties. It has been found advisable to have these geographical maps prepared in the Calcutta office under the superintendence of the Assistant Surveyor-General. The cadastral sheets of Mirzapur, which remained incomplete at the time of the last annual

No. 6 REV. PARTY.

ASSAM SURVEY.



Published under the direction of Colonel G. F. De Prée, R.E., Surveyor General of India.
Survey of India Office, Calcutta, February 1895.

Photo-zincographed at the Survey of India Offices, Calcutta.

report, have been sent to Calcutta to be printed, with the exception of those of a few villages which have still to be kept back pending the settlement of boundary disputes. The 2-inch reductions of the area which has been surveyed cadastrally in Mirzapur are still in the field office under completion, but are nearly finished and ready for despatch to Calcutta. The preparation of these geographical maps has been delayed for want of the topography of the hill portions in 81 of the 16-inch cadastral sheets. This was surveyed during 1883-84 and tested by the Topographical Survey party now employed in the southern portion of the Mirzapur district.

182. The recess office of the party was inspected by the Deputy Surveyor-General in charge Revenue Branch at Naini Tal in September 1883, who was highly satisfied with the arrangements that Major Sandeman had instituted to cope with the vast amount of extra work which now devolves on the party by the additional duty of writing and completing the records and of compiling statistics for the Settlement Department, a work which was new to himself and to all his subordinates. The success of the new procedure in Gorakhpur is largely due to the excellent management of the party by Major Sandeman, and to the energy and professional ability which he has devoted to the work.

183. Major Sandeman acknowledges the very great assistance he has received from the Settlement Officer, Mr. La Touche, in the new and important work now entrusted to the Survey Department, and to whose cordial co-operation in the joint inter-working of the survey and settlement much of the success of the undertaking is due.*

KAMRUP DISTRICT, ASSAM.

(No. 6 PARTY, REVENUE BRANCH.)

184. This party, on the completion of the operations connected with the Hooghly river survey, was directed to undertake the cadastral survey of the Kamrup district in Assam, which was authorized by the Government of India in letter No. 257—10S, dated 9th June 1883, from the Secretary to the Government of India, Revenue and Agricultural Department, to the Surveyor-General.

Personnel.

Mr. E. C. Barrett, Deputy Superintendent, 4th grade, in charge.
„ J. S. Pemberton, Surveyor, 2nd grade.
„ J. H. O'Donel, ditto, 4th do.
„ J. Connor, ditto, 4th do.
„ J. McCay, Assistant Surveyor, 2nd grade, died 24th September.
„ C. S. Kraal, Assistant Surveyor, 2nd grade.
„ J. C. Kelly, ditto, 3rd do.
27 Sub-surveyors and others.

Temporary Establishment.

108 Field surveyors and others.

The professional establishment left Calcutta for Assam on the 28th October 1883, and the boundary traverse operations were commenced on the 10th November: the field survey was started on the arrival of the cadastral establishments from Calcutta on the 17th December. Field work was finally closed on the 22nd May 1884, when the party started for recess quarters at Shillong.

185. Operations were confined to the right bank of the Brahmaputra river, and the most highly cultivated tract in the district, lying between latitude $\frac{26°-15'}{26°-37'}$ and longitude $\frac{91°-18'}{91°-53'}$ was selected for the commencement of operations. At the request of the Chief Commissioner the system recently adopted for the cadastral survey in the Benares district, North-Western Provinces, of requiring the field surveyors to write the field registers (*khasra*) in concert with the *mundal* or village official simultaneously with the measurement of

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* Major Sandeman reports on the European officers and native establishment attached to his party as follows :—

"Lieutenant F. B. Longe, R.E., has been zealous in the performance of his duties. Messrs. Little and Shaw, in charge of cadastral camps, have shown marked capacity and resource in adapting themselves and their establishments to a new procedure involving many new and responsible duties.

"Mr. Freeman deserves great credit for the manner in which he has worked his Traverse Camp. I have no harder working or more trustworthy assistant. Messrs. Murphy, Smart, and Bedford have all worked well.

"Of the native establishment, the English writer Puran Chand has given great satisfaction, and the following men are deserving of mention :—Lachman Sing, Nidha Lal, Lalji mal, Golamgous Khan, Joala Pershad, Fazaldad Khan, Abdul Hadi, Jairam Sing, Hari Sing, Amanat Hosein, Abdul Hamid, Jai Narain, Shib Shai, Har Shai, and Majibullah."

fields has been carried out. The details of the procedure are given in the appendix to this report.

186. The area of cadastral survey completed is 228·16 square miles, comprising 148,438 fields, the average area of which is 0·98 acre. In addition to the completed area, 340 square miles of traverse survey has been prepared in advance for cadastral survey next field season. The unit of survey in the Kamrup district is the "field," which, however, is different to the field unit of other cadastral surveys, as it includes all contiguous plots of the same class of land owned by the same individual.

187. Three stations of the Great Trigonometrical Survey have been connected with the work, and their values have been used for correction of the measured traverses. Azimuths were observed at 36 stations to check the angular work. The field survey has been carefully tested by 556 linear miles of check lines, of which 224 miles were done by the European assistants and 332 miles by inspectors and sub-surveyors.

188. The triple junctions of village boundaries were marked previous to survey by the district staff with stone prisms measuring three feet long and one foot sides, and beyond these marks no demarcation of the boundaries was attempted. The boundaries were surveyed on information obtained on the spot. In addition to the trijunction marks, all the theodolite stations of the boundary traverses have been marked by the surveyors with cylinders of baked clay, measuring from nine inches to one foot in length and from three to four inches in diameter, buried just below the surface of the ground.

189. The cadastral establishment was at first composed chiefly of Hindustanis. Several Bengali *amins*, who had been employed in the late settlement of Cachar, were entertained early in the season; but as they were unacquainted with the professional system of surveying, they had to be put into training for some weeks before they could be entrusted with independent work. Towards the end of February, the establishment of field surveyors consisted of 29 Hindustanis and 42 Bengalis. The daily average outturn of the Hindustani surveyor was 24·5 acres, while the Bengali only accomplished 14·7 acres. No natives of Assam proper have as yet offered themselves for employment as field surveyors; but as survey classes have been opened in the Kamrup district, under the charge of the Deputy Superintendent of Survey, it is expected that some of the pupils may offer themselves for service during the next field season.

190. The work was carried out under conditions of considerable difficulty. On this subject Mr. Barrett reports as follows:—

"Such is the natural fertility of the soil that every square yard of country not under the plough was found closely covered with tall grass and reeds through which the surveyors had to cut their way. The villagers at first offered considerable opposition to the progress of the survey: they refused to point out their boundaries and to clear lines for the traverses, and even objected to the Mahomedans of the survey party remaining in their villages. A considerable amount of friction was the natural result, and it was only owing to the energy and determination of Mr. Stack, the Director of Agriculture, that *mouzadars* and others came to understand that opposition on their part would not be tolerated. The surveyors, however, had to contend against an equally potent cause of delay in the natural sluggishness of the people. The Assami is the most slothful of mortals. His wants are few, and are easily met, and as he considers it degrading to carry a load or to work for any one, the difficulty in securing the labour necessary for clearing the traverse lines may be imagined."

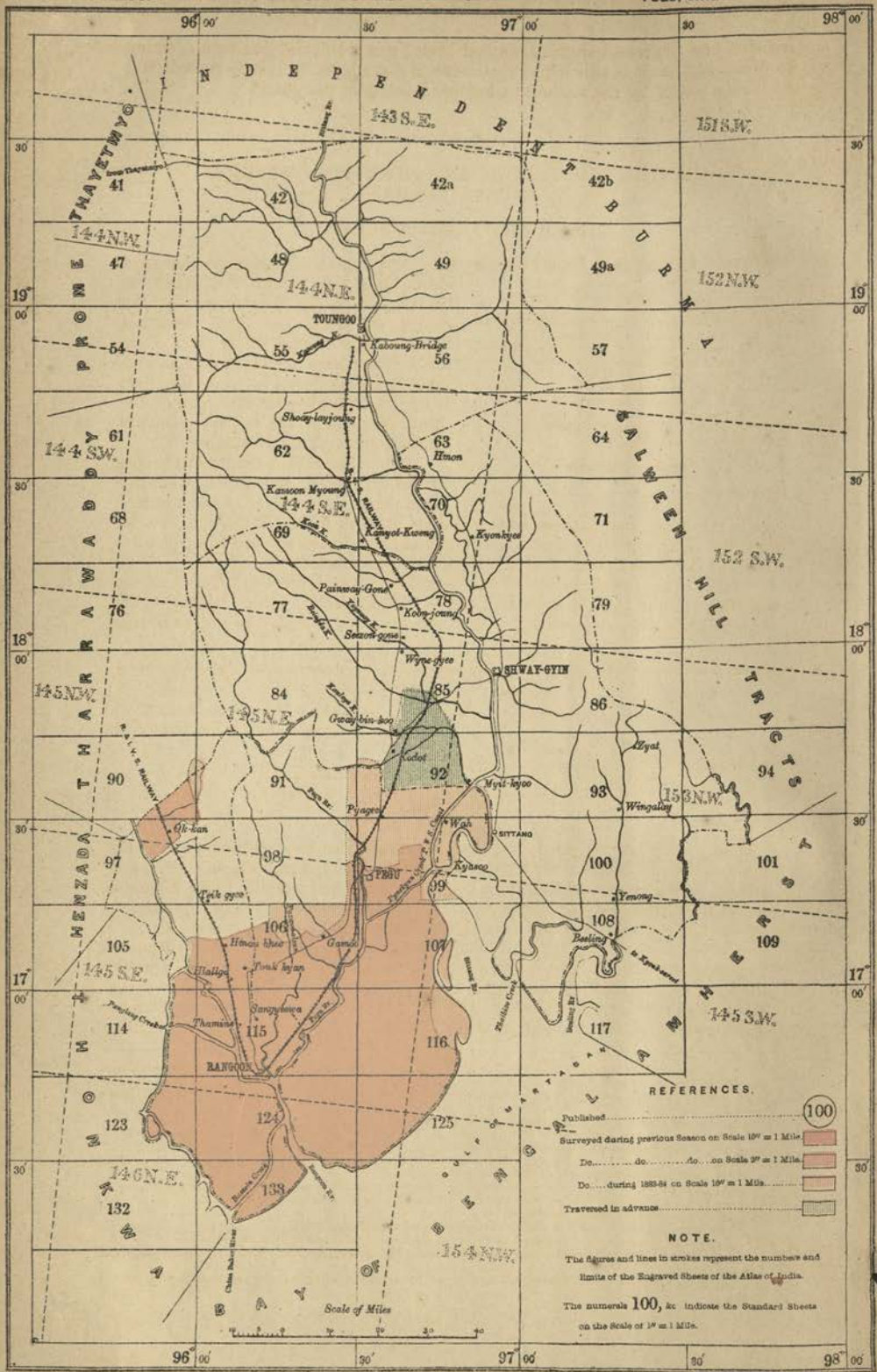
A worse enemy, however, appeared later in the season in the shape of sickness, which materially interfered with the progress of the survey. Towards the end of March fever of a virulent type set in, and within a fortnight 30 per cent. of the establishment was incapacitated for work: only six deaths occurred, but 79 men were invalided, many of whom, it is believed, would have died had they not been sent away.

191. The outturn of cadastral survey has been mapped for reproduction on 381 sheets. *Khasra* and trace maps of all villages have been made over to the Settlement Department for examination. Differences in classification and area between the records of the survey and of the old settlement have been made over to revision parties for examination in the field. A revision squad consists of a settlement *munsarim* and a survey inspector or sub-surveyor: the joint working of settlement and survey is thus maintained. The work of

No. 2 REV. PARTY.

INDEX TO THE BRITISH BURMA CADASTRAL SURVEY.

DISTRICTS HANTHAWADDY, PEGU, SHWAY-GYIN & TOUNGOO.



Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S.C., *Surveyor General of India.*

Survey of India Offices, Calcutta, March.

1885

revision has progressed slower than had been expected during the recess, owing to sickness, but it is still hoped that most, if not all, of the survey records will be finally passed by the settlement before the close of the year.*

HANTHAWADDY, PEGU, AND SHWEGYIN DISTRICTS, BRITISH BURMA.

(No. 2 Party, Revenue Branch.)

192. Up to the 19th February this party remained under the charge of Major J. R. McCullagh, R.E., when, on his transfer to the Mysore survey, the charge devolved on the Assistant Superintendent, and under Mr. Jackson's supervision it has since remained. The boundary section took the field from head-quarters at Rangoon on the 22nd November 1883; the cadastral sections on the 22nd December.

Personnel.

Major J. R. McCullagh, R.E., Deputy Superintendent, 4th grade, in charge to 19th February.
Mr. E. S. Jackson, Officiating Deputy Superintendent, 4th grade, in charge from 20th February.
„ F. Grant, Surveyor, 1st grade.
„ D. A. King, ditto, 4th do.
„ J. McHatton, Assistant Surveyor, 1st grade.
„ G. E. Parker, ditto, 1st do.
„ P. A. Peters, ditto, 2nd do
21 Sub-surveyors and others.

Temporary Establishment.

153 Field surveyors and others.

193. The field operations were continued till the 1st June 1884, when the main party returned to recess quarters, but in the hills some of the squads remained at work till the 15th June, in order that the Pegu district might be completed: the incessant rain subsequent to the 15th May was the cause of the work being protracted.

194. The cadastral survey has been carried on in the Pegu and Pounglin townships of the Pegu district and in the Okkan circle of the Hlaing township, which has been completed. The area surveyed is shown in the following statement:—

Districts.	Townships.	Number of kwins.	Area in square miles.	Remarks.
Pegu	Pegu	188	508·19	
	Pounglin	31	44·31	
Hanthawaddy ...	Hlaing	31	32·24	
	Total ...	250	584·74	

In addition to this area, boundary traversing has been extended over 184 square miles, in preparation for the cadastral survey next season. A larger area of advance work would have been completed had not the Chief Commissioner intimated that no further cadastral operations were to be undertaken by this party after the completion of the survey of the Pegu district.

195. Hitherto the revision of the maps to accord with the settlement papers has been made in the season following the survey, but on the 15th February the local Government, taking in view the revised programme of survey operations in British Burma, by which this party was to be withdrawn in October 1884, requested that in addition to the revision of the past season's work, that

* Mr. Barrett makes particular mention of the great assistance he has received throughout the field season from Mr. Stack, the Director of Agriculture in Assam, to whose hearty co-operation he considers much of the success of the season's operations is due. He also cordially acknowledges the assistance received from the district officials generally.

Mr. Barrett reports on his establishment as follows:—

"Mr. Pemberton has maintained the high character he has always held in the department. He completed his work in good time, and has given general satisfaction.

"Mr. O'Donel is a very superior cadastral officer. He worked his camp with judgment and skill, and exhibited considerable tact in the management of the native establishment.

"Mr. Connor had charge of the boundary camp. He was new to field work, having been employed during the previous 13 years in the head-quarters' office, Calcutta. He has rapidly acquired knowledge of his duties, and promises, to make an excellent camp officer.

"Mr. Kraal is a willing assistant, and Mr. Kelly has worked carefully and steadily."

Among the sub-surveyors and draftsmen the following are commended as having done good service:—

Golam Hyder Khan, Sakhawat Hossein, Khurshed Hossein, Mohan Sing, Janardhan Rao, Tajjuddin, Fida Hossein and Ganga Ram.

Among the temporary establishment, the services of Baboo Sitanath Chuckerbutty are brought prominently to notice.

of the current season's maps should be undertaken. This necessitated the withdrawal of 30 field surveyors from the regular cadastral operations, and thus the outturn of survey has been considerably reduced.

196. The field work of the revision camp began on the 12th December 1883, and by the 9th May 1884 the whole of the two seasons' work, aggregating an area of 1,182 square miles, was revised, and traces of the cultivated portions made over to the Settlement Officer for settlement.

The revisions are due to the usual causes, viz:—

1*st.*—Errors of survey.
2*nd.*—Changes in the boundaries of fields and kwins.
3*rd.*—Imperfect or indistinct demarcation, especially of garden land.
4*th.*—Extension of cultivation.

But the percentage of errata under the above heads is not given.

197. Mr. Jackson reports that—"The demarcation maps were perfectly useless; in fact, they were no guide whatever:" consequently the boundary surveyors were compelled to divide the ground into conveniently sized blocks of 1 to 2 square miles each. All the boundaries thus demarcated by the professional survey have been approved and accepted by the Settlement Department as *kwin* boundaries.

198. The traverse stations of the boundary survey have been made permanent by embedding burnt clay cylinders, and to ensure their due protection, printed notices, with a sketch showing the position of the stations, have been issued to the head men of villages who are made responsible for the preservation of these marks.

199. The country under survey this season was in some places very difficult: one part of the Mayin-zayah circle is described "as a net-work of drainage and swamps, covered with grass 20 feet high, devoid of habitation, and infested with snakes." Mr. Jackson reports that it was with the greatest difficulty that the Mayin-zayah hills were surveyed: the field surveyors were inexperienced in hill surveying, and required to be instructed. These hills are said to be covered with "trees, bamboos, and dense under-growth of cane intertwined with various kinds of creepers, which made the operations exceedingly difficult."

The operations of the season were much scattered, which caused considerable trouble and harassment in superintending the different establishments.

200. The field survey was carefully tested by the European assistants and native inspectors, the amount of check survey by the European officers being 149 linear miles, and by the native agency 347 miles. The work was found to bear the test well. The native surveyors working in the hilly portions were also constantly visited by the assistants. Azimuth observations were taken at 18 stations as a check on the angular work of the traverses: the traverses have been connected with five principal stations of the Great Trigonometrical Survey, and the chain measurements corrected to accord with the triangulation distances. The number of fields in this season's work is 241,744, and the average area of each field is 0·36 of an acre.

201. With regard to the employment of Burmans, Mr. Jackson reports as follows:—

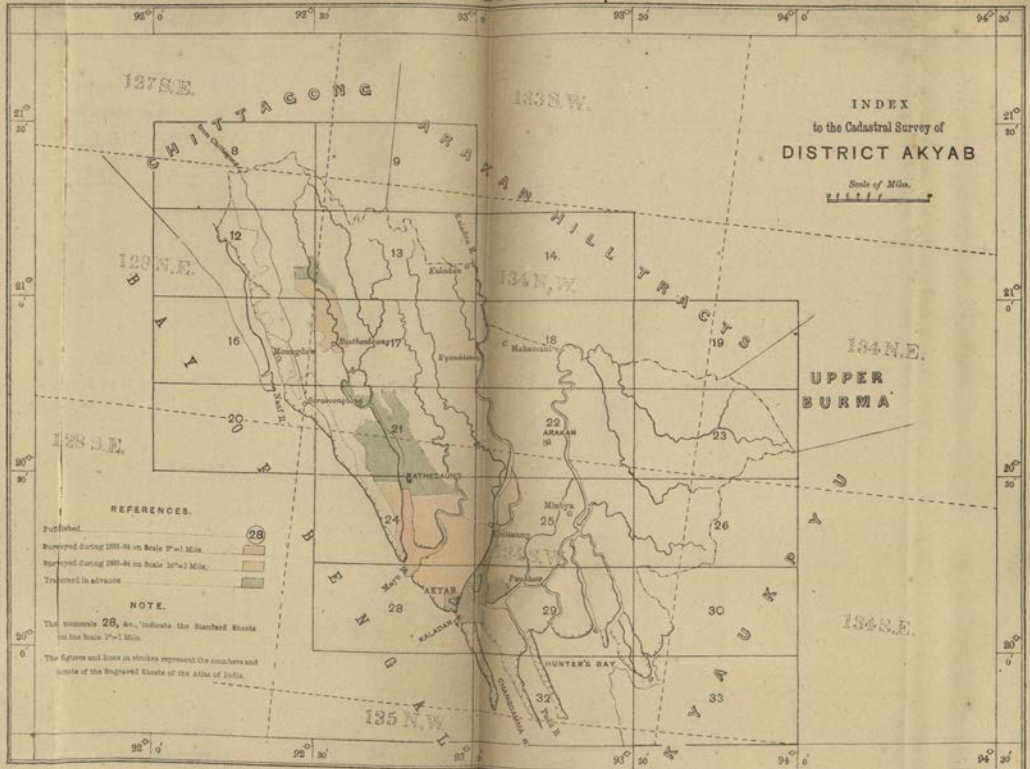
"This season Burmans were employed, of whom 13 did good work in office as calculators, printers, and tracers, and 58 were attached to the field parties and instructed in cadastral surveying: of these 46 passed the survey test and received certificates. They did fairly well in open country, but were found incompetent for surveying in the hills. Twenty-five apprentices also learnt a little surveying and were granted certificates.

"The object of the Burmans is to obtain a survey certificate to qualify themselves for a Thugyiship, &c.; but unless they take to surveying as a profession, there can be but little hope of their ever acquiring that knowledge which is essential for surveying."

202. The 16-inch cadastral sheets, 1,559 in number, of the area finished by the settlement and revision survey—that is, of the area surveyed in the two field seasons 1882-83 and 1883-84—were forwarded to Calcutta for publication between the end of January and the early part of November 1884. Of the general maps on the scale of two inches to the mile, 24 sections have been completed and submitted to be photo-zincographed.

203. The health of the establishment was somewhat better than in previous seasons, which Mr. Jackson attributes to the men having blankets and

BRITISH BURMA SURVEY.



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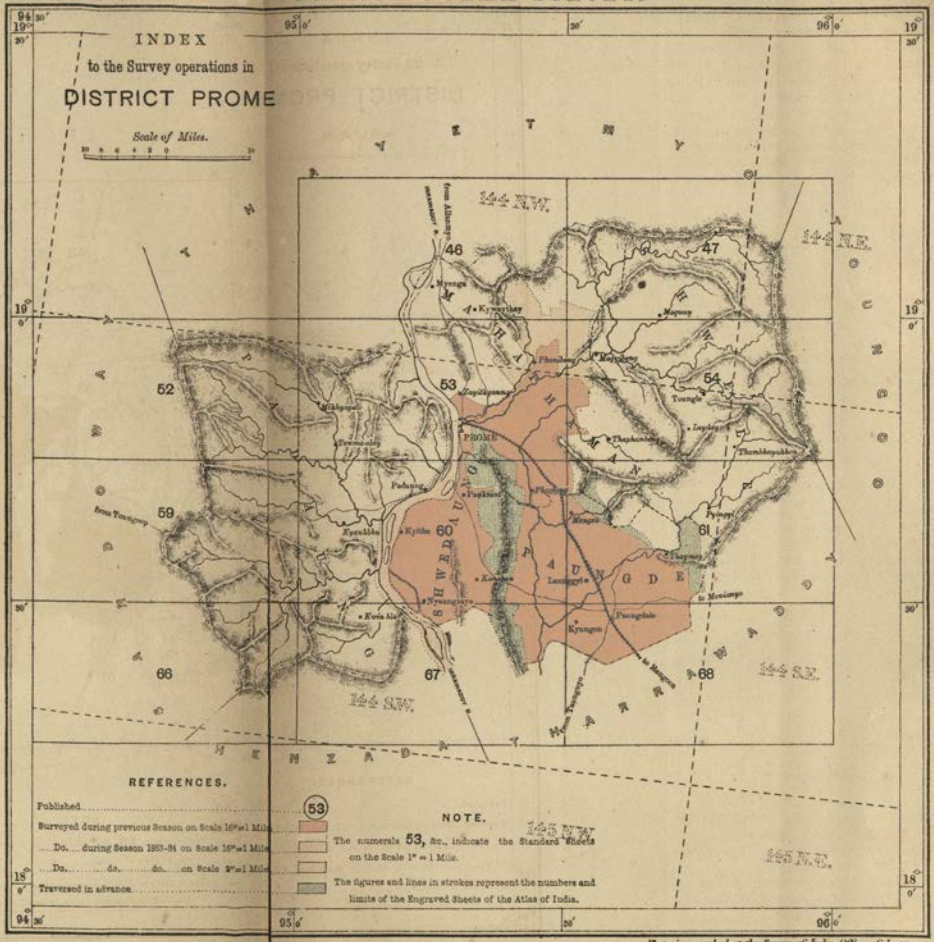
Survey of India Office, Calcutta, February 1885.

Photozincographed at the Survey of India Office, Calcutta.

No. 7 PARTY.

BRITISH BURMA SURVEY.


INDEX
to the Survey operations in
DISTRICT PROME
Scale of Miles.
144 NW.
144 NE.
145 NW
145 NE.
144 SW.
144 SE.
46
47
52
53
54
59
60
61
66
67
68
PROME
Kyauktalon
Paukkaung
Kyauktan
Kyauktaga
Nyaungpin
Kyaukkan
Kyaukka
Kyaukkyi
Kyaukkyi
Kyaukkyi

sleeping under tarpaulins instead of being exposed to the heavy dew, but there was still a good deal of sickness this year, and the European assistants suffered considerably.

204. The levelling squads which had been attached to this party in previous field seasons was transferred to the Henzada district survey.

205. As the cadastral operations of this party have been stopped in accordance with the request of the Chief Commissioner, consequent on his inability to grant any provincial money towards its cost, the organization of the party has been changed to suit it for topographical operations, on which it is to be employed in British Burma under the orders of the Government of India. The trained cadastral establishment has been broken up, and the *amins* have had to seek employment elsewhere. This is much to be regretted, as such establishments take considerable time and trouble to train, and by its disbandment the value of the party for cadastral surveys has been lost.*

PROME AND AKYAB DISTRICTS, BRITISH BURMA.

(No. 7 Party, Revenue Branch.)

206. This party has remained under the charge of Mr. H. B. Talbot throughout the year. Cadastral operations were resumed in the beginning of December 1883 in the Prome district and were commenced in the Akyab district: the field work was continued until the end of May 1884, when the party returned to recess quarters at Rangoon.

Personnel.

Mr. H. B. Talbot, Deputy Superintendent, 4th grade.
„ F. W. Kelly, Assistant Superintendent, 2nd grade.
„ G. W. Jarbo, Assistant Surveyor, 1st grade.
„ J. R. Scott, ditto, 1st do.
„ J. S. Swiney, ditto, 1st do.
„ A. W. Smart, ditto, 1st do.
„ D. J. Collins, ditto, 2nd do.
22 Sub-surveyors and others.

Temporary Establishment.

84 Field surveyors and others.

207. The work in the Prome district was assigned to a detachment under the immediate superintendence of Mr. F. W. Kelly, Assistant Superintendent, while the main party under the Deputy Superintendent carried on the work in the Akyab district.

208. The remaining portion of the Prome district, for which a cadastral survey was required, has been completed, and a topographical survey on the 2-inch scale of the Irrawaddy river has been made from the town of Prome southwards, extending into the Tharrawaddy district up to the point where the river leaves the tract which has been brought under cadastral survey. The cadastral and 2-inch area completed in the Prome district is thus distributed:—

Township.	Scale of survey.	Number of *kwins*.	Number of fields.	Average size of fields.	Cultivation.	Waste.	Total Area.	
							Acres.	Square miles.
				Acres.	Acres.	Acres.		
Mahathaman	16-inch	31	62,551	0·26	16,433	49,873	66,306	103·6
Irrawaddy river	2-inch	.....	.....	.....	... ..	.....	.. ...	100·0
Total „	.....	31	62,551	0·26	16,433	49,873	66,306	203·6

209. A large scale survey of the town of Prome, covering 355 acres, which is included in the above cadastral area, has been made on the field-book system, as in the case of the Bassein town survey. The measurements were

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* Mr. Jackson reports on his establishment as follows:—

"Mr. F. Grant, Surveyor, conducted the duties of cadastral camp No. 1 most satisfactorily, and it gives me pleasure to report very highly of this officer.

"Mr. D. A. King, Surveyor, was in charge of cadastral camp No. 2, and did well in completing the work allotted to him.

"Mr. J. McHatton, Assistant Surveyor, superintended the division camp with credit and to my entire satisfaction.

"Messrs. Parker and Peters, Assistant Surveyors, are excellent assistants, and I have pleasure in reporting favourably of their working powers and the cheerful way they attend to their duties.

"The sub-surveyors, inspectors, and *amins* worked very well."

recorded in field-books kept on the scale of 128 inches to a mile, from which the fair sheets were plotted on the 64-inch scale. This survey has been done in minute detail. Proprietary rights, which had been demarcated by baked clay cylinders, have been carefully fixed and clearly shown on the maps. The Assistant Superintendent and his assistant tested the accuracy of the work by 5½ miles of check survey.

210. The principal work of this detachment, however, was the revision survey, *i.e.* the survey of the changes and extensions of cultivation in the area of 819 square miles surveyed during 1882-83 in districts Tharrawaddy and Prome, and which had been brought under settlement during the current year. This work proved unusually heavy, and occupied 12 Field Surveyors under two Inspectors for five months. The revision survey includes 69,081 fields, of which 37,973 come under the head of changes and 31,108 of extensions since the first survey. The area statements and trace maps were all corrected during the field season, and returned to the Settlement Officer by weekly despatches.

211. The cadastral survey in Prome has been tested by 182 linear miles of check survey, of which 32 miles were executed by European officers, and 150 miles by native inspectors.

212. Regarding the training of Burmans, Mr. Kelly reports as follows:—

"At the request of the Deputy Commissioner of Prome, 14 Burman lads were received for instruction in surveying—9 from Prome and 5 from Tharrawaddy. They were taught the use of the plane-table, chain, and optical square, and practised in the survey of fields: in office they were also taught how to calculate field areas with the acre comb. The Deputy Commissioner's object for this training was to make these lads qualify for Thugyiships; but as it is not possible to make a Surveyor in a few months, certificates of proficiency could not be granted, though the most was made of the limited time allowed for their instruction."

213. The season's outturn of cadastral survey in Prome has been mapped in 110 sheets, of which the traces and area statements have been supplied to the Settlement Officer for his operations in 1884-85. These sheets have been kept back to complete the revisions thereon. A trustworthy Inspector and a few Field Surveyors will be placed at the disposal of the Settlement Officer during the ensuing field season for this object. The original sheets, 1,007 in number, of the area cadastrally surveyed in 1882-83 have been finally examined and despatched to Calcutta for publication. Of the 19 Standard Sheets of district Tharrawaddy on the 2-inch scale, 15 sheets have been completed and sent to Calcutta, and the remaining four are well advanced.

214. In the Akyab district no preparatory traversing had been done in advance, as the orders for this survey were not received in time to utilize the Boundary Surveyors there, while the party was working in the Prome district during the previous year. It had been intended to withdraw this party from Burma in order to employ it on the cadastral survey in Assam; but this arrangement was subsequently counterordered, unfortunately, too late, as the boundary camps had been broken up and the traverse surveyors sent on leave. For the first month of the season under report, therefore, the operations had to be confined to preliminary operations. These were commenced on the 20th November 1883, and the detail survey was started about the end of December.

215. In January 1884, when the work was in full swing, the Chief Commissioner announced the necessity of stopping all survey expenditure from the 1st October following, in consequence of the want of funds. The Deputy Superintendent then received orders, in a letter No. 75—68, dated 10th January 1884, from the Secretary to the Chief Commissioner, not to take up more work than could be conveniently completed by the end of October. The programme originally laid out for the season was thereupon altered, and the survey of certain waste land grants, which was considered of the first importance, was directed to be undertaken. The necessary movements of the surveyors on this change of programme had no sooner taken place than fresh orders were received from the Chief Commissioner rescinding the former order, and stating that since survey operations in the Akyab district will not be stopped in October next, the original programme for the season was to be carried out. The surveyors had therefore to be sent back again to their former ground, and thus between two and three weeks of work was lost.

216. The separate areas of the different townships, and the total area which has been surveyed in the Akyab district on the different scales, are given in the following statement:—

Township.	Scale of survey.	Number of *kwins*.	Total Area.	
			Acres.	Square miles.
Kyele	16-inch	37	33,544	52·41
Urittaung, West	.....	85	76,184	119·04
Rathaydaung	.....	75	58,531	91·46
Kalapanzin	.....	11	24,962	39·00
			193,221	301·91
Mayu river	2-inch	3	40,320	63·00
Total ...	.....	211	233,541	364·91

By the cadastral survey, 580,000 fields have been surveyed, having an average size of 0·18 acre on the cultivated area. In addition to the above, boundary traversing has been extended over an area of 263 square miles in advance, in preparation for cadastral survey next season. The area of completed survey is small, but it is as large as could be expected under the circumstances. The small outturn is due to the following causes:—(i) in the want of preparatory traverses for the detail Surveyors; (ii) the delays caused by the several changes of programme; (iii) the small size of the fields; and (iv) the large number of men sick in April and May.

217. The field survey has been carefully tested by 552 linear miles of check surveys, of which 255 miles were executed by the European assistants and 297 miles by the native inspectors. The work was found to be honestly and carefully done. The angular work of the traverse survey has been checked by azimuth observations taken at 46 stations; and connection with 12 stations of the Great Trigonometrical Survey enabled the chain measurements to be adjusted to agree with the trigonometrical distances.

218. The temporary demarcation was very defective, especially in the Ambari circle, and of little use to the Boundary Surveyors, who were further hampered by the want of assistance from the headmen of the villages. The theodolite stations have all been marked with stone prisms, which will serve as permanent reference points for future changes and extensions. The posts by which the waste land grants in Akyab had been demarcated by Mr. H. Dowman in 1881-82 have not been disturbed, as the Deputy Superintendent thinks there is no necessity to make them more permanent: the posts, being of iron wood, called *pyingado*, are likely to last for the next ten years.

219. Mr. Talbot reports as follows on the Arakanese:—

"There were in all 26 Arakanese under training during the field season: six of these passed the examination required of them, and were given survey certificaties; some of the remainder are now at work learning office duties, and it is hoped that 15 of these men will be employed in plane-tabling during the coming season, and that at least 30 or 40 more will be in training.

"The Arakanese, compared with the Burmans, are not so independent: they do not dress so well, nor squander as much money in amusements, and are ertainly not so hospitable. They are decidedly more intelligent than the Burmans, but they are equally fond of drinking and gambling, and are just as lazy and vindictive."

220. The 16-inch sheets, 460 in number, on which the season's outturn in Akyab has been mapped, have been drawn, with the exception of a few sheets in which the hilly portions are incomplete. The area statements and traces of the 208 *kwins* will, it is expected, be made over to the Settlement Officer in due time to commence the revision.

221. According to the revised programme of survey operations in British Burma, this party is to be retained for the completion of the survey of the Akyab district at full strength up to the end of 1885-86, and in 1886-87 at half strength. The cadastral operations therefore will be resumed by the entire party in Akyab in the ensuing season.*

GEOGRAPHICAL AND MISCELLANEOUS.

SIKKIM, DARJEELING, AND NEPAL BOUNDARY SURVEY.

222. The following shows the different descriptions of work performed by this party, and the officers who have been employed thereon:—

Personnel.

Brevet-Colonel H. C. B. Tanner, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. E. C. Ryall, Assistant Superintendent, 1st grade.
Mr. J. Peyton, Surveyor, 1st grade.
„ W. J. O'Sullivan, do., 4th do.
„ W. Robert, Assistant do., 1st do.
„ W. C. G. Barckley, do. do., 1st do.
„ R. W. Senior, do. do., 3rd do.

Sub-Surveyors.

Sahai Din and others.

(1) Sumeswar Hills Survey, Mr. E. C. Ryall, Assistant Superintendent, and Mr. Senior, Assistant Surveyor;

(2) Daling Hills Survey, Mr. Peyton, Surveyor, and Mr. Robert, Assistant Surveyor;

(3) Sikkim Survey, Mr. Robert and Rinzin Nimgyl, explorer;

(4) Triangulation and distant sketching of Himalayan topography, Colonel Tanner, Mr. O'Sullivan, Mr. Robert, Mr. Barckley, and Mr. Senior;

(5) Demarcation and surveys on the Nepal-Bengal Boundary, Mr. E. C. Ryall and Mr. Senior;

(6) Explorations in Tibet, the Lama.

223. The survey of the Sumeswar hills on the scale of 1 mile=1 inch embraces an area of 685 square miles, and was effected by Messrs. E. C. Ryall and R. W. Senior. Along the watershed which forms the Nepal boundary stone prisms are being set up at those places where the ridge is not well defined. The tract embraced by the two sheets of the Sumeswar survey is similar in all respects to the Sewalik range which forms the southern limit of Dehra Dún, except that the peaks are generally of less altitude and the *cheer* or *pinus longifolia* is almost entirely absent. A strip of the Nepal territory which skirts the boundary has been sketched as far as circumstances would permit, and large errors in the existing engraved atlas sheet have been corrected. The operations were of the most tedious nature owing to the innumerable deep ravines and sandstone scarps which intersect the tract in all directions.

224. The survey has not been extended beyond Tribeni Ghat on the Gunduk river, and it is in contemplation to complete the work during 1885 down the Gunduk river to pillar No. 1 of the North-Western Provinces Nepal boundary.

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* Mr. Talbot reports on his assistants as follows:—"Mr. F. W. Kelly, Assistant Superintendent, completed the survey of the area that remained in the Prome district to my entire satisfaction. He is well up in all his duties, and will give satisfaction whenever appointed to the charges of a party."

Messrs. Jarbo, Scott, Swiney, and Smart are reported to have worked well, and to have given satisfaction; but the Deputy Superintendent regrets he cannot write in the same terms of Mr. Collins.

The native establishment on the whole worked well. The following members are specially mentioned:—Computers, Dindyal and Shashi Bhusan Ghosal; Sub-Surveyors, Faiz Buksh, Mr. LaRive, and Isan Chunder Ghosal.

225. The Daling hills survey on the scale of 8 inches=1 mile embraces an area of 29½ square miles: it was undertaken to map and demarcate certain lands in the outer hills which had been set apart by Government for tea cultivation. A trigonometrical survey was first made of the tract, and afterwards the lands were cut up into convenient blocks which were traversed and then topographically surveyed. The permanent demarcation of the tea estates is now being carried out—natural features only—such as streams and ridges being utilized as boundaries. Pillars are being built wherever the natural features do not sufficiently indicate the exact boundary. These maps will prove of the greatest use in clearly defining, without possibility of doubt, the estates of tea-planters. The work was effected by Messrs. Peyton and Robert, and was much retarded by the hazy or cloudy weather. Dense jungle clothes the hill sides and proved a serious obstacle to progress. The rectangular co-ordinates of the trigonometrical stations have been referred to the centre of the degree which embraces the work.

Area 29½ square miles mapped in 7 sheets on the scale of 8 inches =1 mile.

226. The eastern extremity of the Daling hills touches Bhutan territory, and advantage has been taken of this to sketch a considerable amount of topography in Bhutan.

227. Mr. Robert's survey of North Sikkim is the most important piece of work effected by this party during the season under review: it is on the scale of ½ inch=1 mile and embraces an area of 760 square miles. We now have a map of the whole of the southern slopes of the Himalayas which skirt Sikkim to the north and which cut the outlying tract of Chumbi (Tsumbi) from the remainder of Tibet. Except a small three-cornered bit north-west of Kinchinjinga, we have the whole of the great spurs and snow fields which compose the group of that name. Every pass leading out of Sikkim into Bhutan, Tibet and Nepal has now been fixed, and all the routes have been entered on the map. Mr. Robert's operations were carried on under the hardships always experienced by surveyors in the higher Himalayas. Besides the new surveys brought in by Mr. Robert, Captain Harman's section of Independent Sikkim has been enlarged and incorporated with the remainder of the topography. North of the Donkia pass, Hooker's topography has been utilized.

228. Every opportunity of extending our knowledge of the Himalayas has been taken advantage of, and up to the end of November almost every peak and ridge that could be seen from the plains of Bengal has been fixed by Colonel Tanner by triangulation between Sikkim on the east and the Durbhunga district on the west: besides this a large amount of work of the same nature has been carried out by Mr. Barckley from the tower stations in the Chumparun district. The gap between the work of Colonel Tanner and Mr. Barckley will probably be filled up during the ensuing year. Smoke, haze, cloud and fog greatly retarded the operations.

229. The demarcation and surveys on the Nepal-Bengal boundary have been completed from the Koosee river to Tribeni Ghat on the Gunduck, and the renumbering of all pillars and posts is now in progress.

230. Mr. Ryall executed certain large scale surveys of small newly-settled portions of boundary, where owing to the erosion of rivers the marks of Wyatt's survey of 40 years ago were constantly being washed away, and these small portions of boundary are now being permanently demarcated with iron posts. The excavation of the ditch and repair of the boundary pillars between the Koosee and Beknatori was carried out by Messrs. O'Sullivan and Barckley.

231. The interesting tract of country comprised by sheet No. 6 of the new trans-frontier maps has been plotted from the field-books of the Lama, and we now have very complete knowledge of the whole of the country between Darjeeling and Lhasa. The Lama's surveys include a close reconnaissance of the interesting Yámdok or Palti Lake of D'Anville, of the newly-discovered lakes of Tigu-tso and Pho-Mo-Chang-Thang, and of many passes and valleys between Bhutan and Lhasa, which previous to the Lama's exploration were altogether unknown.

TIDAL AND LEVELLING OPERATIONS.

THE TIDAL OPERATIONS.

232. The recording of the tidal curves by the self-registering gauges, their reduction, and the publication of the tables of predicted tides have continued as usual during the past year. Major Baird, requiring six months' leave on urgent private affairs, was relieved of his charge during that period by Major Hill from 4th April to 20th August, when he was relieved by Mr. H. E. T. Keelan, Surveyor, 1st grade, who retained charge till Major Baird's return.

Personnel.

Major A. W. Baird, R.E., Deputy Superintendent, 3rd grade, in charge to 4th April 1884.
Major J. Hill, R.E., Deputy Superintendent, 3rd grade, in charge from 4th April to 20th August 1884.
Mr. H. E. T. Keelan, Surveyor, 1st grade, in charge from 20th August 1884.

(Tidal.)

Mr. T. H. Rendell, Surveyor, 4th grade.
„ E. J. Connor, ditto, 4th do.
Sub-Surveyor Dhondu Venayek.

(Revision of Heights and Levelling.)

Mr. H. E. T. Keelan, Surveyor, 1st grade.
„ G. Belcham, ditto, 3rd do.
Sub-Surveyor Narsingdass and three recorders.

233. The tidal observations were continued at 19 stations, viz :—

Aden.	Galle.	Diamond Harbour.
Kurrachee.	Negapatam.	Kidderpore.
Bombay.	Madras.	Rangoon.
Marmagão.	Vizagapatam.	Elephant Point.
Beypore.	False Point.	Amherst.
Colombo.	Dublat (Saugor Island).	Moulmein.
		Port Blair.

Of these, Marmagão, Galle, and Colombo are new stations. Two stations, Kárwár and Pámban, have ceased to exist. Five years' observations had been secured at Kárwár, while at Pámban, on account of the long break which must necessarily have followed the damage done to the observatory by the storm of the 26th December 1882—and as four years' observations were completed—the instruments were taken down and the observatory removed.

234. The whole of the observatories were visited and inspected once, or oftener, during the past year, either by Major Baird or by an assistant, and every instrument was thoroughly overhauled and cleaned during the inspection of each observatory.

235. The reductions of the observations have progressed steadily, and the final results have been determined, so that the co-efficients should be presented in the manner recommended by Professor Darwin and explained in the report submitted last year (*see* appendix). The new computation forms for the analysis of all the short-period tides which were drawn up by Mr. Roberts in accordance with the modifications proposed by Professor Darwin were received in time to be used in the reductions of last year's observations; but the new forms for the long-period tides have not yet been completed by Mr. Roberts, and meanwhile the old forms are still in use.

236. The account of the working of each tidal observatory will be found in the appendix. They all appear to have worked satisfactorily, with only the ordinary accidental stoppages, excepting at Port Blair, where unfortunately the Port Officer, not understanding the scope of the operations, suspended them for six weeks, and at Amherst again the windows of the observatory were twice broken open and the gauge put out of gear by some mischievous, unknown persons. A similar statement had to be made in last year's report (p. 45). The Secretary to the Chief Commissioner has been appealed to and requested to prevent the recurrence of such wanton mischief.

237. Major Baird's office at Poona has during the past year had an unusual burden thrown upon it. This officer reported last year (*vide* p. 18 of appendix to Annual Report 1882-83) that Professor Darwin had pointed out that there had been a slight error in the determination of the tidal co-efficients, viz. the omission to take cognizance of the variation of the inclination of the place of the moon's orbit to the equator, and as this varies from year to year, the computed amplitudes of the lunar and luni-solar constituents required slight modification to render them strictly comparable year by year; consequently a mass of new computations had to be undertaken to present the

co-efficients in a modified and strictly accurate form. This is reported on in detail by Major Baird in the appendix to the present volume.

238. Due notice of this modification of the method of presenting the co-efficients is given in the prefaces to the tide-tables for 1885, which contain predicted tides for 20 ports, the same number as in the tables for 1884. The usual interesting statements showing the errors in the predicted heights and times of high and low water for 1883 will be found in the appendix. The predictions for 1883 must be considered very good, and may be summarized as follows:—

Percentage of predictions within 15 *minutes of actuals.*

	High water.	Low water.
Open coast stations ...	... 72 per cent.	... 70 per cent.
Riverain „ ...	... 70 „	... 66 „

Percentage of predictions within 8 *inches in height of actuals.*

	High water.	Low water.
Open coast stations ...	... 92 per cent.	... 96 per cent.
Riverain „ ...	... 66 „	... 64 „

The same remark applies regarding the Moulmein and Amherst predictions as was stated last year. The predictions at the former station were better than those at Amherst, and similarly the predictions at Kidderpore and Diamond Harbour were better than those for Dublat. Thus it will be necessary to treat Amherst and Dublat in the predictions as riverain ports, and not as open coast stations.*

SPIRIT-LEVELLING OPERATIONS.

1.—THE OPERATIONS EXECUTED IN CONNECTION WITH THE TIDAL OBSERVATIONS.

239. In paragraph 246 at page 52 of the Annual Report for 1882-83 will be found a brief but interesting notice of the longest line of levels ever run between two seas, viz. that from Kurrachee *viâ* Mithankot, Ferozepore, Agra, Allahabad, Monghyr, and Calcutta to False Point, a distance of 2,300 miles, of which the last connecting link was completed in the season then under review. During the past season a similar connecting link has been interpolated between Sironj and a station 32 miles north of Manmád, on the Bombay and Agra Road, completing a line of levels between two sea-coast stations, second in length, by very little, to the chain above referred to, and consisting partly of that same chain, *i.e.*, from Kurrachee to Agra, but thence to Bombay; and the error was only ·624 of a foot, or less than four inches per 1,000 miles.

The length of the link completed during the past season was over 425 miles, over ground with rises and falls amounting in aggregate to nearly 22,000 feet, constituting a very satisfactory outturn.

240. At Kurrachee a short line of levels was run between the tide-gauge station and a benchmark on Trinity Church which had hitherto derived its value (as had indeed all the stations on the great line of levels emanating from Kurrachee) from the value of mean sea-level determined in 1855 by a short series of observations extending over two semi-lunations. The result of the comparison is eminently satisfactory, exhibiting a discrepancy of but one hundredth of a foot between the old (1855) and present values of mean sea-level.

241. In addition to the spirit-levelling operations, the revision of the heights on the Khánpisura Series has been continued and brought within four stations of completion. The whole would have been completed but for Mr. Keelan,

* Major Baird reports favourably on the services rendered by Mr. Rendell, and also of Dhondu Vinayek and the other sub-surveyors, and of Hanmantras Bajoojee, mechanic, connected with the field works.
Mr. Connor is highly commended for the way in which he and his staff of computers grappled with the work.

to whom the work was entrusted, being compelled to take 1½ months' leave during the field season on account of a severe attack of inflammation of the eye.

242. The total cost of these operations is as under:—

	Rs.
Tidal	28,197
Spirit-levelling	17,248
Trigonometrical	11,217
Total ...	56,662

This gives average cost-rates of Rs. 1,484 per tidal station, Rs. 40½ per linear mile of double spirit levelling, and Rs. 701 per principal station of which the height has been trigonometrically determined.*

2.—THE OPERATIONS IN CONNECTION WITH THE REVENUE SURVEY.

243. The small party of levellers in British Burma, which had been attached to the Hanthawaddy district survey party, was transferred to that working in the Henzada district under the superintendence of Major Hutchinson, and resumed its operations in December 1883 near Henzada in continuance of the programme arranged for the plan of levels in the Irrawaddy valley. The Ngawun Valley Series was commenced at the junction of the Irrawaddy and Ngawun rivers. Starting from bench mark No. 8 of the Irrawaddy Valley Series, this section has been carried along the embankment on the left bank of the Ngawun river as far as Ngathein-gyoung: from this point a tie-line has been carried eastwards *viâ* Kyônpyaw and Ataung to Danúbyú on the Irrawaddy, and a connection again made on the Irrawaddy Series. The length of this section is 89 miles, and the closing error is 0·0217 foot per mile, which is a very satisfactory result. Having assured the accuracy of the work as far as Ngathein-gyoung, the Ngawun River Series was extended therefrom, and it has been carried as far as Ngaputaw, about 20 miles below Bassein. At this point the operations had to be closed on account of the setting in of the rains. The total length of line of levels measured is 169 miles, with double levelling throughout. The number of bench marks fixed is 169. It is intended to continue the Ngawun Series as far as Pagoda Point, at the mouth of the Bassein river, during the ensuing season, and to endeavour to carry a cross line from Bassein to Pantanaw, closing again on the Irrawaddy Series. This will complete the scheme of levels as far as it has yet been projected.

GEODETIC.

ELECTRO-TELEGRAPHIC LONGITUDE OPERATIONS.

244. The two astronomical parties were engaged in the extension of the Electro-telegraphic Longitude Arcs eastwards of Calcutta, and measured during the season the six arcs, Akyab-Calcutta, Akyab-Chittagong, Prome-Chittagong, Prome-Akyab, Moulmein-Prome, and Moulmein-Akyab, thus completing the link between Kurrachee and Moulmein.

Personnel.

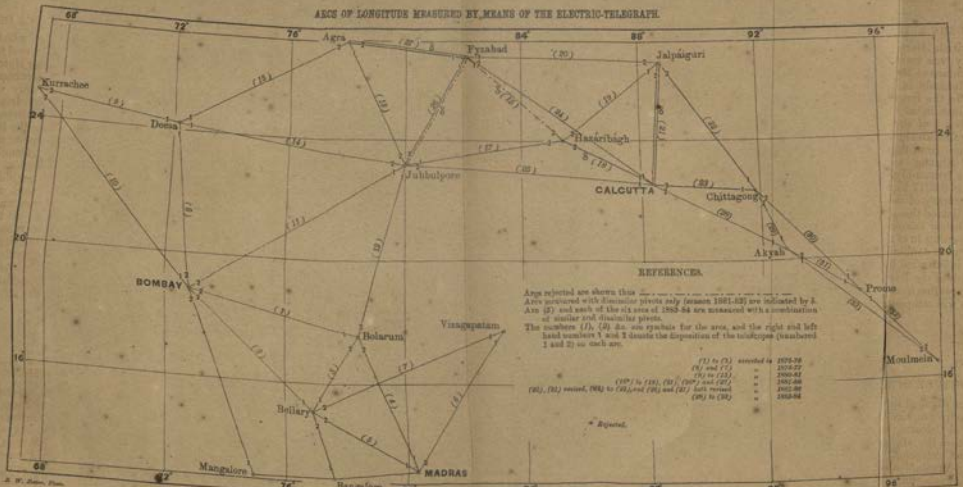
(No. 1 Astronomical Party.)
Major W. J. Heaviside, R.E., Deputy Superintendent, 3rd grade, in charge.
Mr. D. Atkinson, Surveyor, 1st grade.
Sub-Surveyors.
Baboo Dhonâe Balwant Joshi.
„ Tikha Ram.

(No. 2 Astronomical Party.)
Major G. Strahan, R.E., Deputy Superintendent, 2nd grade, in charge to 29th April 1884 (on subsidiary leave and furlough thereafter).
Major W. J. Heaviside, R.E., Deputy Superintendent, 3rd grade, in charge from 30th April.
Sub-Surveyor.
Baboo Harsahai.

245. Unusual delays were met with owing to bad weather, to the changes from station to station being dependent on weekly coasting steamers, and to the failure on more than one occasion of the Madras-Penang cable, which threw the whole of the China and Straits traffic with countries to the west on to the main lines through Burma, and so choked them with traffic that the line could not be spared for the longitude work.

* Major Baird makes special mention of Mr. Belcham, to whom the work was entrusted, and also of his assistant Narsing Dass.

ARCS OF LONGITUDE MEASURED BY MEANS OF THE ELECTRIC-TELEGRAPH.



R. W. Bates, Photo.

Published under the direction of Colonel G. C. DePree, R.C., Surveyor General of India.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, November 1884.

C. C. Wilson, Sc.

246. The computations have all been brought up to date, some slight revision required for the work of 1882-83 has been completed, and the manuscript of the details of the observations for the three seasons 1881-82 to 1883-84 has been arranged for print.

247. The existence of defects in the two transit instruments has been commented on in the annual reports of the past two years; and in last year's report will be found, at pages 53 to 57, a discussion of the errors resulting therefrom, proving that they changed sign with a reversal of pivots, and affording ground for suspicion that the *locale* of the defects is in the Ys. During the past season observations were taken (in accordance with the intention expressed in paragraph 260, page 58 of last year's general report) with a combination of what has been termed (see paragraph 251 of last year's report) *similar* and *dissimilar* pivots, for the purpose of eliminating, as far as possible by differences, these residual errors in the determination of the differential arcs of longitude, and of determining their values for each instrument by the exhibition of their sum and difference; and, in addition, independent observations were taken specially for the purpose of determining the residual errors in each instrument separately. The method of taking these latter observations will be found described in Major Heaviside's report, and the results of the observations, both regular and special, have been drawn up, tabulated, and discussed by him in conjunction with Mr. Hennessey, and will be found in the same report. The magnitudes of the residual errors have now been pretty accurately ascertained for each instrument, and very accordant results are obtained by the application of corresponding corrections; but as the defects causing these errors were likely to prove a source of continued anxiety to observers, and moreover as their exact *locale* has not been definitely discovered—there being other possible causes of instability besides that suspected by Mr. Hennessey (page 58 of last year's report)—it was resolved to send both instruments to England to be thoroughly examined and have the defects rectified by the makers; and Major G. Strahan, being now on furlough in England, has been invited to inspect the instruments, on the maker's report of completion of repairs, and to see that the defects are removed before the instruments are returned to this country.

248. The instruments having been sent to England for repairs, longitude operations are at a standstill, and the combined parties will be employed under Major Heaviside in observing astronomical latitudes about the meridian of 80° along the Madras, the Jubbulpore, and the Amua Meridional Series to within 30 or 40 miles of the Himalayas.

249. Major Heaviside acknowledges the cordial assistance rendered by the officers of the Telegraph Department.*

* Major Heaviside reports favourably of Mr. D. Atkinson and of Baboo Dhondo Balwant Joshi.

PART III.

THE OPERATIONS AT THE SEVERAL HEAD-QUARTERS OFFICES.

1. These offices comprise—

(1)—The Survey of India Offices at the presidency.
(2)—The Trigonometrical Branch Office at Dehra.

There has been no change in the general arrangement of these offices during the year under report: in all the work has increased, as will be found by reference to the separate reports of each office. The amalgamation of the clerks of all the branches into one general list has been completed, a step rendered necessary by their being all brought into one establishment.

Personnel.

Colonel J. Scottee, s.c., Deputy Surveyor-General, in charge Revenue Surveys up to 4th March 1884.
Lieutenant-Colonel H. R. Thuillier, R.E., Deputy Surveyor-General, in charge Revenue Surveys, from 5th March 1884.
Major C. Strahan, R.E., Deputy Superintendent, 2nd grade, Assistant Surveyor-General.
Lieutenant-Colonel W. H. Wilkins, S.C., Deputy Superintendent, 3rd grade, officiating in 2nd grade, from 14th March 1884.
Major M. W. Rogers, R.E., Deputy Superintendent, 3rd grade, Assistant Surveyor-General.
G. H. Cooke, Esq., Assistant Superintendent, 1st grade, Officiating Deputy Superintendent, 4th grade, from 17th August 1884.
Captain St. G. C. Gore, R.E., Assistant Superintendent, 1st grade, Officiating Deputy Superintendent, 4th grade, up to 14th August 1884.

SURVEY OF INDIA OFFICES.

Mr. T. W. Babonau, Registrar.

SURVEYOR-GENERAL'S OFFICE.

Correspondence Section.

Mr. M. Francis, Head Clerk.
Babu Bance Madhub Banerjee.
„ Chuni Lall Dey and one other.

Account Section.

Mr. E. D. Algar, Head Accountant.
Babu Bama Churn Chuckerbutty.
„ Raj Krishna Mookerjee and six others.

General Section.

Mr. T. E. Ware, Examiner.
„ J. A. Vallis.
Babu Bheecum Singh.
„ Gopal Chunder Doss and six others.

REVENUE SURVEY BRANCH OFFICE.

Mr. A. C. Cunningham, Head Clerk.
Babu Kali Pado Banerjee.
„ Ram Kristo Chunder and two others.

TOPOGRAPHICAL SURVEY BRANCH OFFICE.

Mr. F. A. D'Rozario, Head Clerk.
Babu Doorga Narain Ghose and one other.

MAP RECORD AND ISSUE OFFICE.

Mr. A. E. Byrn, Head Assistant.
„ P. C. H. Smart, Map Curator.
„ H. R. Vallis, Map Salesman, and six others.

DRAWING OFFICE.

Mr. A. Chamarett, Chief Draftsman, up to 1st June 1884.
Mr. G. A. McGill, Chief Draftsman, from 2nd June 1884.
Mr. S. M. Smylie, Head Draftsman.
„ R. C. D. Ewing, Draftsman.
„ W Green, ditto.
„ J. R. Adels, ditto.
„ A. J. Musgrove, ditto.
„ R. Sinclair, ditto.
„ W. P. Smith, ditto.
„ A. S. Bateman and two others.

Native Draftsmen.

Munshi Sunaullah.
„ Nabi-Buksh.
Babu Hariher Sen.
„ Mohesh Chunder Shaw.
Munshi Muttiullah.
Babu Purna Chandra Sein.
„ Radhicaprosad Doss, and 36 others.

Surveyors and Assistant Surveyors on duty.

Mr. G. A. McGill, Surveyor, 1st grade, up to 1st June 1884.
Mr. W. Todd, Surveyor, 2nd grade.
„ J. A. May, ditto, ditto.
„ F. Adams, ditto, ditto.
„ W. Stotesbury, Surveyor, 4th grade, from 24th June to 31st August 1884.
Mr. P. J. W. Doras, Assistant Surveyor, 1st grade.
„ S. O. Madras, Assistant Surveyor, 2nd grade, from 7th May 1884.
Mr. E. J. Martin, Assistant Surveyor, 1st grade.
„ B. M. Wilson, Assistant Surveyor, 2nd grade.
„ T. J. J. Mills, Assistant Surveyor, 3rd grade, from 14th March.
Mr. P. J. Serrao, Assistant Surveyor, 3rd grade, from 24th April.

Additional Establishment.

Mr. W. Stotesbury, from 1st September 1884, and eight others.

ENGRAVING OFFICE.

Mr. C. W. Coard, Superintendent, on furlough from 15th April 1884.
Mr. W. Donaldson.
„ G. G. Palmer.
„ D. L. Mitchell, on furlough from 1st April 1884.
„ J. Pelford.
„ T. B. Hodger.
„ A. G. Palmer, on furlough from 1st May 1884.
„ S. M. Coard.
„ A. W. N. James.
„ A. R. Coard.
„ A. D. M. Chamarett.
„ E. C. Ollenbach, and 25 native Engravers.

Copper-plate Printing Section.

Mr. W. T. Collins, Copper-plate printer, and 15 native printers and pressmen.

2. In the Map Record and Issue Office great efforts have been made to provide for the proper storing and arrangement of the vast amount of maps which are in the custody of this section.

3. The duties of the Surveyor-General's and the Topographical Branch Offices have been carried on by Major M. W. Rogers, R.E.*

4. The Revenue Branch Office was supervised by Colonel J. Sconce, the Deputy Surveyor-General in charge Revenue Surveys, up to 4th March 1884, and subsequently by Lieutenant-Colonel H. R. Thuillier, R.E.: these officers have carried on all the duties connected with the accounts as well as the correspondence of the branch.†

Lieutenant-Colonel W. H. Wilkins on his return from furlough on 14th March 1884 was posted to the head-quarters offices, and assisted the Deputy Surveyor-General in charge Revenue Surveys in general administration. In addition to this duty he has been in charge of the Map Record and Issue Office from 19th March 1884.

5. Captain St. G. C. Gore, R.E., officiated as Personal Assistant, and was also in charge of the Map Record and Issue Office from 10th January to 18th March 1884. He accompanied the Surveyor-General to Simla, and assisted him in general administration duties up to 14th August 1884, when he was attached to the Afghan Boundary Commission, and in his place Mr. G. H. Cooke was appointed Personal Assistant to the Surveyor-General from 17th August 1884.

Map Record and Issue Office.

6. The work done by the Map Record and Issue Office during the past year ending 30th September 1884 is shown in the following statement:—

Maps issued.	No.	Value.
		Rs.
General maps to Government officials ...	50,727	57,431
Ditto to India Office, London ...	2,920	4,172
Ditto to agents	3,077	4,170
Total ...	56,724	65,773
Cadastral maps to Government officials ...	142,333	1,06,749
Grand Total ...	199,057	1,72,522

7. The number of applications received during the past year for extracts from original records of the revenue surveys was 535, for copying which Rs. 3,989 were received and paid to the copyists.

	Rs.
Amount realized from the resident map salesman and paid into the Government treasury	4,386
Ditto mofussil agents ditto	4,184‡
Total ...	8,570
Applications received for maps by letters, indents, and telegrams	2,684
Letters issued	1,955
Invoices and receipts issued	1,646
Packets, parcels, and town despatches	2,450
Sheets coloured for sale and issue	24,643
Ditto for other departments	4,437

* Major Rogers reports as follows:—

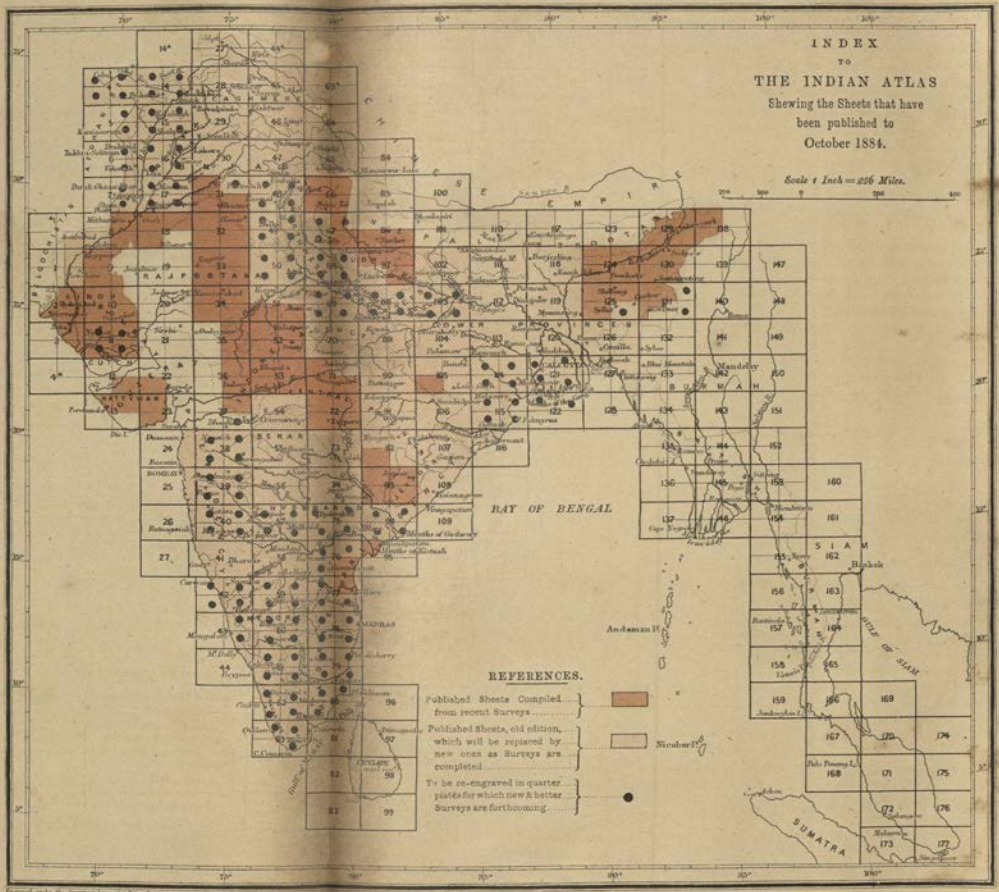
"Mr. Babonau, the Registrar, has continued to discharge his duties satisfactorily and energetically.

In the Surveyor-General's and Topographical Branch Offices Messrs. Francis and D'Rozario and Babus Banee Madhub Banerjee, Doorga Narain Ghose, Bama Churn Chuckerbutty, Chuni Lall Dey, and Mohendro Chunder Aich are deserving of special notice. Mr. J. A. Vallis, Babus Bheecum Singh, Rajkissen Mukerjee, Gopal Chunder Doss, Okhoy Coomar Dutt, Hemnath Dutt, and the rest of the clerks have given satisfaction."

† In the Revenue Survey Branch Office, the Deputy Surveyor-General specially mentions the services of Messrs. A. C. Cunningham, E. D. Algar, and Babu Kali Pado Banerjee who have worked assiduously and well. Babus Ram Kristo Chunder, Raj Coomar Dutt, with the rest of the clerks, have given satisfaction.

‡ Includes portion of value of maps sold during 1882-83.

To accompany Surveyor General's Report for 1883-84.


INDEX
TO
THE INDIAN ATLAS
Shewing the Sheets that have
been published to
October 1884.
Scale 1 Inch = 226 Miles.
BAY OF BENGAL
Andaman Is.
Nicobar Is.
SIAM
GULF OF SIAM
SUMATRA
REFERENCES.
Published Sheets Compiled from recent Surveys
Published Sheets, old edition, which will be replaced by new ones as Surveys are completed
To be re-engraved in quarter plates for which new & better Surveys are forthcoming

Engraved under the Superintendence of C.Wood.

Published under the direction of Colonel G. C. DePree, R.C., Surveyor General of India,
at the Survey of India Offices, Calcutta, February 1885.

8. The total number of maps issued is nearly 200,000, and their value over a lakh and a half. These figures are somewhat below those of previous years, and may be attributed to the introduction of a more judicious system in the issue of published maps. Formerly they were issued broadcast to all military and civil officers, but now they are issued only on application, except in the case of certain departments which should possess all maps directly they are published.

9. Great care is taken that all trans-frontier and other confidential maps are issued only to those officers who are entitled to receive them under special orders of the Foreign Department, and they are stamped "absolutely confidential," with a foot-note directing that all such maps are to be returned to the Registrar, Survey of India Office, directly they are no longer required. The necessary arrangements to keep all confidential maps securely locked are nearly completed, and they will in due course be entrusted to the officer in charge of the Map Record and Issue Office.

10. During the past year the resident map agent died shortly after his resignation. The work devolved on the officer in charge of this office, who made suitable arrangements for carrying it on by improved agency. The work of the map salesman has considerably increased since the abolition of Messrs. Thacker Spink & Co.'s agency.*

11. Considerable progress has been made in the arranging and sorting of original maps and records, and it is hoped that this important work will be finally completed during 1885. In addition to the work of re-arranging the records, a revised and comprehensive catalogue of published maps is under preparation, but its compilation will take considerable time. The chaos which has existed ever since the entry of the Survey of India Office into the new building, from the insufficient rack accommodation, as well as from the want of a sufficient establishment to arrange the maps, is rapidly disappearing. The racks have all been arranged in methodical order, admitting of the proper classification of published maps. Every available inch of space has been or will be occupied by additional racks reaching to the ceiling, fixed at a small cost in comparison to the great improvement made, as the accommodation will be more than doubled, which is necessary in view of the coming cadastral surveys.†

DRAWING OFFICE.

12. The two sections of the drawing office, viz. that which is principally employed in new compilations, and passing topographical maps on to the Photographic Office for reproduction and publication, and that which deals with all maps connected with revenue surveys, have done equally well. The statement given in the appendix shows the very large amount of work turned out. All details will be found in that statement, but particular attention may be called to the following which have been dealt with in section I. The district maps of Bengal, Assam, the North-West Provinces and Oudh, and the Punjab on the scale of 1 inch=8 miles for administration reports, all of which had to be specially drawn, with the exception of a few in the North-West Provinces, were commenced: the final orders and full instructions as to how these were to be prepared were only received in June 1884, and sanction was obtained for the entertainment of a small temporary establishment, the office not being able to cope with so large a task without the employment of extra hands. It is hoped that these maps will all be ready for printing by about March 1885, or earlier.

Rough preliminary editions of these maps had been prepared last year, but for reasons stated in that year's report were found to be unsuitable. As soon as they have been finally passed and approved by the local authorities, they will be engraved on copper by one of the new processes.

13. Provincial index maps for Assam, Bengal, the North-West Provinces and Oudh, the Punjab, Rajputana, and Central India are now completed, and all maps henceforth published will be furnished with these new numbers. Fresh

* The agency for the sale of maps was withdrawn from Messrs. Thacker, Spink & Co. during the year, partly on account of their persistent refusal to submit their accounts in proper time, and partly because this office is now able to undertake the sale of its own publications without the intervention of an agent.

† Colonel Wilkins reports that Mr. Byrn has given every satisfaction. Mr. Smart has performed the duties of map curator most efficiently, and Mr. Vallis has carried on the duties of map salesman most satisfactorily. Mr. Doran has had the charge of the re-arrangement of the printed records, and has shown intelligence and industry in carrying on work.

editions of all old maps will also have these new numbers given to them, and in this way the old, irregular indexes will be gradually superseded. Some of the sheets of Central India along the eastern boundary have been either redrawn altogether or have been filled up to margin, the blanks being copied from the revenue surveys of our territory, so that the series of 1-inch standard maps may be unbroken and complete: these will be renumbered according to the new index. One sheet on the 4-inch scale of the Andaman survey has been published, as well as maps of the two volcanic islands of Narcondum and Barren. The map of the Paropamisan mountains, by Pottinger, was redrawn and printed by photo-zincography for the use of the Boundary Commission, the whole process only occupying six days.

14. Of Afghanistan, a preliminary edition of sheet No. 12 was prepared for the use of the Zhob expedition, whilst sheets Nos. 5, 6, 8, 9, and 11 were redrawn and published in two colours, the outline in black and the hills in brown. Of Baluchistan, sheets Nos. 10 N, 10 S, and 7 N were published.

15. The old topographical sheets of the Nizam's dominions have been redrawn in the regular standard form on the 1 and $\frac{1}{2}$ inch scales, and in a style fit for reproduction by photo-zincography. The materials are very old, but they form the only maps of that part of the country. The following sheets have been completed and published:—11 sheets of Suggur, 1 sheet of Pangul, 1 sheet of Ghanpurra, 11 sheets of Raichur, 9 sheets of Golkonda, and 7 sheets of Koolberga. A 16-mile map of Guzerat, Kattywar, and Cutch has been completed in outline as far as materials exist: this, as well as the Punjab and North-West Provinces maps, on the same scale, will be eventually engraved. The North-West Provinces map is still in the hands of the draftsmen.

16. Some of the special maps drawn for the Calcutta International Exhibition have been prepared for publication: those exhibiting trade routes, distribution of languages, and river basins have just been printed: the rainfall, railway, and telegraph maps were already published. Those showing density of population, distribution of the different religions and missionary stations are under preparation. It has been found impossible without a very great expenditure of labour to prepare the forest map in such a way as to enable it to be printed; and the data forthcoming for the crop map occupies, comparatively speaking, so small a portion of India, and it is so laborious a map to draw, that it has been set aside for the present.

The maps of India, atlas sheets, and other engraved maps have been kept up to date as far as possible. The regular examination of maps before sending for reproduction, the correction of boundaries according to published orders, &c., have been carried on as usual. Besides this, a new edition of the military cantonment of Saugor on the 8-inch scale has been commenced; the necessary corrections having been obtained from the Executive Engineer's office. Standard Sheets on the 1-inch scale of districts Mozufferpore and Durbhunga in Bengal, and of Gogaira in the Punjab, have been drawn, and proofs have been sent to the local authorities for insertion of roads and canals, and for the examination of boundaries.

17. Eighty-seven 4-inch and 2-inch diagonal sheets of districts Bhagulpur, Durbhunga, Gonda, Bharaich, Kheri, and Terai, abutting on Nepal, were corrected and prepared for reproduction to scale by photo-zincography for the Foreign Office. These are intended especially to illustrate the boundary between Nepal and British territory, and are to be bound up into volumes for easy reference. The necessary computations for recompiling the old Bengal district maps into the uniform 1-inch Standard Sheets have been steadily carried on, but it is a very tedious and difficult matter making the necessary connection between the old maps and the modern triangulation. The final drawing of these maps is done by the Lithographic Office.

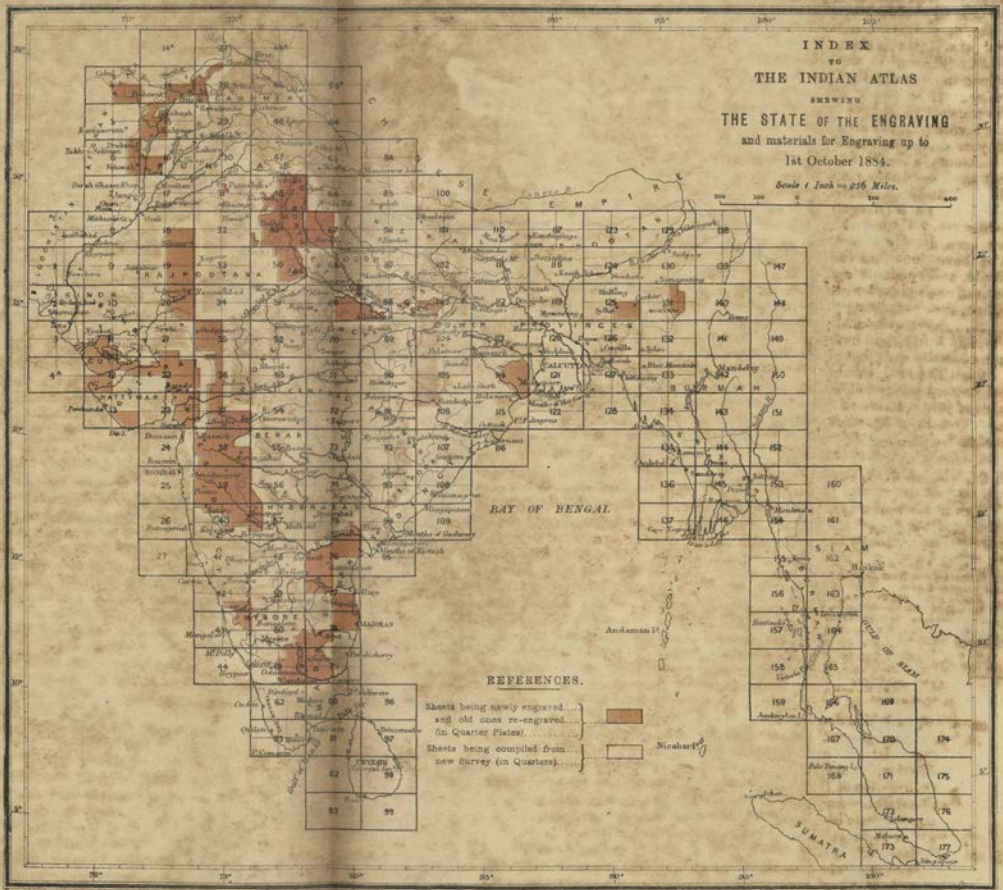
18. A good deal of extra pressure has been thrown on this section by the transfer of two of the assistants, both of whom were obliged to leave Calcutta on account of ill-health just as they had learnt their work in this office.*

* Major Strahan reports that Mr. Chamarett, the head draftsman in the Topographical Branch of this office, retired on a pension after 31 years' service, during which he had distinguished himself by zeal and ability. He was succeeded by Mr. G. A. McGill, who has performed his duties in a very satisfactory manner. Mr. Adams has been in charge of the examining section and to his exertions may be attributed its successful outturn.

Mr. Smylie, in charge of the Revenue section of the Drawing office, has done his work thoroughly.

Mr. Ewing, in charge of the Cadastral Examining office, is a very zealous assistant, and the remaining assistant Surveyors have all worked very satisfactorily.

To accompany Surveyor General's Report for 1883-84.



Published under the direction of Colonel G. C. DePree R.E., Surveyor General of India,
At the Survey of India Offices, Calcutta, February 1885.

ENGRAVING OFFICE.

19. The work in this office may be divided into three classes—(1) the lettering and outlining, (2) the hill etching, and (3) the copper-plate printing. The outturn in (1) and (3) is decidedly greater, but in (2) it is less than that of last year. The staff of hill-etchers is at all times small, and this year it has been seriously reduced by the death of one and the prolonged illness of another of the native engravers, in addition to the absence on furlough of two of the Europeans. To this alone is due the smaller outturn of work in class (2).

20. The work of the Printing office annually increases, and is likely to continue to do so with the introduction of heliogravure. This process will enable us to engrave on copper, at a comparatively small cost and in a very short time, maps which it would have been quite impracticable to engrave by hand. Several heliogravure plates of articles exhibited at the Calcutta International Exhibition last year have been printed, and the system is being gradually introduced as the assistants in the Photographic office become more expert.

21. The 64-mile map of India and the Himalayan route map have been published, and good progress has been made in the 32-mile map of India; sheet No. 4 of the latter (Bengal) has been completed, and the hills are being etched on sheet No. 1 (Punjab and North-West Himalayas), sheets Nos. 5 and 6 have been already completed, and sheet No. 3 is finished in outline. Four plates have been machine-ruled for section paper, and twelve plates of latitude and longitude scales on 1-inch and ½-inch for all India have been engraved; one plate for projecting maps on the 1-inch scale has also been finished, thus completing the whole series of these graticule plates.

22. Seven quarter atlas sheets have been finished, forty-eight are in progress, and thirty-eight have been repaired and added to, showing an increase of work generally over that of last year.

23. The total number of plates in hand during the year was 210. The total outturn was as follows:—1,527 square inches of hill-etching; 50 square inches of jungle etched; 4,081 square inches of outlining and 259,202 letters cut. The Printing office pulled 19,054 impressions, of which 384 were transfers.*

THE LITHOGRAPHIC OFFICE.

24. Major J. Waterhouse was in charge of this office throughout the year.

The number of maps, plans, drawings, &c., printed off during the year amounts to 702, of which 202 (including 49 forms) were departmental and 500 extra departmental. The type work shows a large increase both in subjects printed and in the number of impressions.

Personnel.

Major J. Waterhouse, R.E., Assistant Surveyor-General, in charge.
Mr. H. L. Lepage,* Head Assistant.
„ L. C. Cunningham, Head Draftsman.
Munshi Mahommed Azim, „ Subhan Buksh, and 24 others, } Draftsmen.
Mr. D. Deas, Head Lithographic Printer.
„ B. Wilson, Assistant ditto, and 74 others.
„ E. DePyvah, Head Type Printer, and 25 others.
Five clerks and 12 others.
Mr. G. A. LeFranc. " E. Dowling. } Apprentices.

* Returned from furlough on 5th July. Mr. A. G. Palmer officiated for him until 1st May, and Mr. L. C. Cunningham till his return.

25. A third edition of the map of India, scale 1 inch=32 miles, in six sheets, has been prepared and published during the year, with additions and corrections to date. A map of Afghanistan on the scale of 1 inch=4 miles has been commenced, and one sheet, with hills drawn on stone, is nearly completed.

26. A commencement has been made of lithographing the series of maps showing the material state and progress of India, which was exhibited at the Calcutta Exhibition. Maps of India on the scale of 1 inch=96 miles, illustrating the Distribution of Languages and the Principal River Basins, have been prepared and printed. An Irrigation Map on the 32-mile scale and a Missionary map on the 64-mile scale have been prepared, but not printed.

27. Further progress has been made with the Contour Map of India, but it is not yet printed off.

28. Among the provincial maps is one of the Nizam's Dominions, in two sheets, on the scale of 1 inch=16 miles, drawn on stone by Mr. Cunningham, the head draftsman. The drawing of one sheet was completed, but it has not been printed.

* Major Strahan reports that Mr. Coard, the head engraver, took furlough for 5½ months, and Mr. Palmer was appointed temporarily to the vacant post till the end of the year. Mr. Coard Mr. Palmer, and the European and native assistants have continued to perform their duties satisfactorily.

29. Ten sheets of the new edition of standard sheets of Oudh on the 1-inch scale have been drawn, and four published during the year. Six new district maps, viz. Jubbulpore, Lakhimpur, Howrah, Chanda, Cachar, and Hoshungabad, have been prepared by transfer from the engraved sheets of the Atlas of India, and the three first have been printed off: three sheets of the Indian Atlas have also been transferred to stone and printed off.

30. The amount of extra departmental work again shows an increase; 496 subjects, comprised in 500 sheets, were received, and 108,146 copies printed, the value of the work being Rs. 23,213.

31. The Rainfall Chart of India, noticed in last year's report, was completed and printed.

32. A crown-size lithographic machine, suitable for working by hand, indented for last year, was received at the close of the year. After some necessary repairs it has been set up, and is likely to prove very useful for printing jobs of the full size of a sheet of foolscap, such as forms and the new provincial and district administration maps, of which large numbers will constantly be required. The outturn, when working by hand, is about 300 an hour.

33. A series of specimens of maps and drawings executed in the office was exhibited at the Calcutta International Exhibition and gained a gold medal.*

THE PHOTOGRAPHIC OFFICE.

34. The outturn of the Photographic Office is shown in the annexed abstract. The number of original drawings, &c., sent in for reproduction was 211 less than last year, and consequently there is a falling off in the outturn of the presses, especially in the item of departmental maps. The extra departmental work shows, however, a slight increase. The total number of cadastral maps reproduced was 5,202, or 89 more than last year, but the number of copies printed off was 6,825 less than last year. In addition to the ordinary photo-zincographic work of the office, a much larger amount of silver printing has been done than usual, and the collotype and heliogravure processes have been developed and utilized in connection with the Calcutta International Exhibition.

35. Statements showing the comparative outturn of the various sections of the office during the present and

Personnel

Major J. Waterhouse, R.S.C., Assistant Surveyor-General in charge.

NEGATIVE SECTION.

Normal Establishment.

Mr. J. Mackenzie, Photographer, 11th January to 30th September 1884.
„ Mr. A. W. Turner, Officiating Photographer, 13th November 1883 to 10th January 1884.
C. DeCruzé, Assistant Photographer.
Ismail Khan, ditto.
2 Negative Retouchers, 2 Glass-cleaners, and 1 Bhistee.

Cadastral Establishment.

Mr. C. Marshall, Photographer.
„ L. Lagnier, ditto.
„ T. Lloyd, Assistant Photographer.
„ J. B Mackenzie, Assistant Photographer, 1st September 1883 to 31st July 1884.
3 Assistant Photographers, 8 Negative Retouchers, 5 Glass-cleaners, and 1 Bhistee.

PHOTOGRAPHIC TRANSFER PRINTING SECTION.

Normal Establishment.

Mr. J. Harrold, Photographer.
Habibul Hossain, Assistant Photographer.
2 Labourers.

Cadastral Establishment.

Mr. R. George, Photographer.
2 Assistant Photographers, 4 Labourers.

SILVER PRINTING SECTION.

Normal Establishment.

Mr. G. G. Dempster, Photographer.
1 Assistant Photographer and 1 Labourer.

HELIOGRAVURE AND COLLOTYPE SECTION.

Normal Establishment.

Mr. A. W. Turner, Photographer, from 1st May 1884, for 8 months.
Baboo Kally Das Seal, Draftsman and Engraver, transferred from the Marine Survey Office, 1st September 1884.
1 Assistant Photographer, 4 pressmen, and 1 copper-plate printer.

ZINC PRINTING SECTION.

Normal Establishment.

Mr. B. Mackenzie, Zincographer.
1 Writer, 4 zinc-correctors, 5 zinc-printers, 4 spongemen, 14 pressmen, and 8 grainers.

Cadastral Establishment.

Mr. J. Watson, Zincographer.
„ E. A. LePrane, ditto.
„ J. B. Mackenzie, Assistant Zincographer, 1st August to 30th September 1884.
1 Writer, 9 zinc-correctors, 9 zinc-printers, 6 spongemen, 30 pressmen, and 11 zinc-grainers

GENERAL OFFICE ESTABLISHMENT.

Normal Establishment.

Mr. W. Moore, Store-keeper.
Baboo Kanny Lall Sen, Clerk and Accountant.
1 Clerk.

Cadastral Establishment.

Mr. H. Haward, Head Assistant, from 11th January 1884.
Mr. J. Mackenzie, Officiating Head Assistant, 1st September 1883 to 10th January 1884.
1 Clerk.

APPRENTICES.

Normal Establishment.

C. J. Meade.
J. T. Meade.
S. U. Ravenscroft.
P. C. Michael.

* Major Waterhouse reports favourably of the conduct of the European assistants, Mr. H. L. Lepage, Head Assistant, Mr. A. G. Palmer, Officiating Head Assistant, Mr J. Watson, Officiating Head Printer, Mr. D. Deas, Head Printer, Mr. L. C. Cunningham, Head Draftsman, Mr. B. Wilson, Assistant Lithographic Printer, and Mr. E. DePyvah, Type Printer. The native draftsmen and clerks have also worked satisfactorily.

past year, of expenditure and value of work done, and of work done for other departments are given in the appendix.

36. The value of the printed maps and other subjects printed during the year has been—

	Rs.
Departmental	23,986
Extra departmental	24,568
Cadastral	73,358
Other receipts	4,721
Total ...	1,26,633

37. The expenditure for establishment and stores has been heavy during the year owing to the cost of new presses and apparatus, as well as increased establishment and house-rent, and amounts to Rs. 1,27,763, or Rs. 1,230 in excess of the receipts.

38. Mr. H. Haward, who was appointed Head Assistant by the Secretary of State for India, arrived in January, and as he was specially skilled in working the photo-collotype processes, and brought out with him a fresh supply of the necessary apparatus and stores, a commencement was again made with this useful but delicate and difficult process. Mr. Haward has succeeded fairly well in overcoming many of the difficulties which beset such work in this country, and has reproduced and printed off 1,150 copies of the gold medal award certificates for the Calcutta International Exhibition, and has also, by way of practice and training for his assistants, printed several plates from a series of negatives of Indian art-work taken during the Exhibition. The process is exceedingly well adapted for delicate work of this kind, and for other purposes where copies of ordinary photographs are required in large numbers.

39. The heliogravure processes have also made good progress during the year. With the aid of Mr. A. W. Turner, Major Waterhouse has introduced a new process which has some advantages over the one hitherto in use, and appears likely to be successful and particularly useful for map work. In the ordinary heliogravure or photo-electrotype process, described in full in the appendix to the annual report for 1881-82, the engraved copper plate is obtained by developing a positive pigment print, or relief in hardened gelatine, on a silvered copper plate, and then depositing copper upon it so as to form a new copper plate which bears the design in intaglio and is capable of being printed in the copper-plate press.

In the new process a *negative* pigment print is developed on a copper plate, and the intaglio image is obtained direct on the plate by biting in with a chemical solution which penetrates the gelatine film comparatively easily in those parts representing the shadows of the picture or lines of a map, where there is little or no gelatine, and bites the copper to a considerable depth; whereas, in the parts representing the light of the picture or the ground of a map, where the gelatine is thicker, it penetrates with more and more difficulty as the thickness of the gelatine increases, and in the highest lights should leave the copper untouched. The operation of biting does not take more than five minutes, and the engraved images are marvellous in their delicacy of gradation and richness of effect. The greatest care has, however, to be taken with such delicate work, and it is difficult to get sufficient depth to stand printing without the loss of the finest tints. Much may, however, be done by rebiting, especially in line work, such as maps, and it is in this direction that the process seems most likely to be useful, and has already been employed in reproducing some of the new administrative maps of districts. Its great advantage is its rapidity, a day or at most two being sufficient to prepare the etched plate, whereas by the photo-electrotype it takes three weeks or

a month to deposit a printing plate of sufficient thickness. Full details of the new method as worked out by Mr. Turner are given in the appendix.

40. Besides the preparation of a series of specimens of the work produced by the various processes employed in the office, for the Calcutta International Exhibition (for which a gold medal was awarded to the office), a good deal of work was done in connection with the Exhibition by heliogravure and collotype in printing the award certificates and photographing and reproducing a series of 200 photographs of some of the principal objects of Indian art-work exhibited from various parts of the empire. The photographs were taken by Mr. Turner at the cost of the Government of Bengal, and it is proposed to publish a selection of them in a permanent form as soon as a sufficient number of plates can be got ready. Several sets of silver prints of these photographs have been printed in the office.

41. The operations of the office were interfered with by a fire which occurred on the 1st November in the upper story of No. 1, Wood Street, and necessitated the repair of the premises, besides entailing considerable loss and damage to public property, as already fully reported.

42. Under the orders of Government, four apprentices have been entertained in the office, viz. C. J. Meade, J. T. Meade, and S. U. Ravenscroft from the 1st August, and P. Michael from the 1st September. The lads are of a good stamp, industrious and steady, and seem likely to be useful.*

A.

Abstract of Work performed in the Photographic Office, Survey of India Department, from 1st October 1883 to 30th September 1884.

	Original sections or sheets.	Negative plates.	Photographic transfer prints.	Number of plates.	Number of pulls.	Number of printed sheets of each subject. Single.	Number of printed sheets of each subject. Combined.	Silver and other prints.	Collotype prints.	Heliogravure plates.	Cost. Rs. A. P.
General maps	16	49	53	52	3,840	2,748	1,203	...	...	...	1,570 11 4
Provincial maps	5	10	10	5	708	708	604	...	...	...	255 14 10
Divisional ,,	4	16	16	...	...	...	...	...	...	...	164 4 0
District ,,	46	60	60	19	1,809	2,169	1,719	8	...	...	1,053 14 4
Plans of cities and cantonments	8	24	24	11	1,130	1,130	960	...	...	...	562 15 10
Atlas sheets	1	6	6	1	50	50	50	...	...	...	73 1 9
Standard sheets	253	583	592	129	21,331	21,451	19,308	...	...	...	11,336 13 11
Index maps	11	15	24	15	4,648	5,518	4,518	...	...	...	880 6 1
Technical charts	5	8	8	3	80	105	105	...	...	...	117 13 8
Miscellaneous maps and plans—departmental	208	246	175	108	7,748	7,763	6,555	646	790	19	4,292 15 4
Ditto ditto— extra departmental	390	852	961	369	57,918	89,222	78,520	1,557	2,523	4	21,374 12 9
Transfers and proofs	...	...	...	...	2,262	...	...	...	...	...	.....
Total ...	941	1,869	1,929	713	101,472	133,844	113,452	2,211	3,313	23	41,383 12 10
Cadastral—North-Western Provinces.											
Photo-zincographs	805	805	873	876	9,335	9,335	5,158	...	...	...	13,439 14 0
Zincographs	916	...	...	916	9,446	9,446	7,700	...	...	...	9,263 8 0
Total ...	1,721	805	873	1,792	18,781	18,781	12,858	...	...	...	22,703 6 0
Cadastral—British Burmah.											
Photo-zincographs	1,347	1,349	1,321	1,154	19,136	19,136	18,510	...	...	...	18,680 6 0
Zincographs	512	...	...	512	17,397	17,397	7,775	...	...	...	5,724 1 0
Total ...	1,859	1,349	1,321	1,666	36,533	36,533	26,285	...	...	...	24,404 7 0
Cadastral—Bengal.											
Photo-zincographs	824	824	801	827	33,626	33,626	7,992	...	...	...	15,056 3 0
Zincographs	798	..	...	798	33,604	33,604	11,739	...	...	...	11,491 5 0
Total ...	1,622	824	801	1,625	67,230	67,230	19,731	...	...	...	26,547 8 0
Transfers and proofs—Cadastral maps	...	...	...	...	10,647	...	...	...	...	...	.....
Cadastral Maps Total ...	5,202	2,978	2,995	5,083	133,191	122,544	58,874	...	...	...	73,655 5 0
GRAND TOTAL ...	6,143	4,847	4,924	5,796	234,663	256,388	172,326	2,211	3,313	23	115,039 1 10

*Major Waterhouse reports favourably of his European assistants: Messrs. J. Mackenzie, B. Mackenzie, J. Watson, Herold, C. Marshall, R. George, L. Lagnier, A. E. LeFranc, and G. G. Dempster, also of the Head Clerk Baboo Lal Lal Sen, who have all worked with their usual zeal and steadiness. Mr. A. W. Turner, who was appointed temporarily as special assistant, has done good service, and been most useful in developing the heliogravure processes during work connected with the Exhibition. Mr. H. Haward has worked hard and steadily in overcoming the difficulties of collotype-printing.

MATHEMATICAL INSTRUMENT OFFICE.

43. During the financial year 1883-84 this office has been fully employed in supplying the ever-increasing demands for instruments and repairs which are made on it by all the departments in India.

Personnel.

Major R. V. Riddell, R.E., from 1st to 18th April 1883.
Major M. W. Rogers, R.E., from 19th April.

Workshop Branch.

Mr. T. Bolton, Mathematical Instrument-maker.
„ F. Marshall, Assistant ditto.
64 Artificers on the permanent establishment.
91 (on an average) artificers on the contingent establishment.

Store Branch.

Mr. G. R. Alderman, Instrument Store-keeper.
Babu Womesh Chunder Chowdhry, Material Store-keeper.
1 Packing sircar.
2 Packers.

Office Establishment.

Mr. M. O'Brien, Head Clerk.
„ C. O. Grey, 2nd clerk.
6 Other permanent clerks.
1 Extra clerk, from 1st April to 16th July 1883, made permanent from 17th July 1883.

The equipment of two new cadastral survey parties caused a large demand for new instruments, and an extra grant of Rs. 5,000 was obtained from Government and fully utilized.

44. As was mentioned in last year's report, the increased demand for current repairs necessitated a corresponding diminution in the manufacture of new instruments and in the repairing for re-issue of any portion of the great stock of repairable instruments which has been accumulating in the Store Branch. A representation of this was made to the Surveyor-General by the officer in charge, and sanction was obtained from Government for a temporary extra grant of Rs. 300 per mensem for the workshop establishment, by means of which it is hoped that some impression will be made on the large accumulation of repairable instruments. The effect of this grant is not, however, apparent in the year under report, as the money was not sanctioned until its close.

45. A great change was introduced in the system of keeping the workshop accounts, and the procedure was greatly simplified, with the result of diminishing the clerical labour without impairing its accuracy and the constant check which it is necessary to keep on the issue and consumption of materials.

46. The stock was increased by a total receipt of 35,375 instruments, amounting in value to Rs. 1,30,059, the detail of which is as follows:—5,746 instruments, in value about Rs. 55,934, were received from England; 10,888 were locally purchased at a cost of Rs. 10,495; 14,866 were manufactured in the workshop at a cost of about Rs. 22,833; 3,875, valued at Rs. 40,797, were received by departmental exchange, of which 559 were serviceable and 3,316 were repairable. Further, 1,428 instruments, forming part of the repairable stock, were repaired on the premises and rendered fit for future issue at a cost of Rs. 10,721, which, after repair, were valued at Rs. 36,296. This, for the reasons above stated, is a considerable decrease from last year.

47. The issue of instruments to various departments during the year amounted in number to 33,365 and in value to Rs. 1,61,529. Their distribution was as under—

	Number.	Value.
		Rs.
Survey of India Department	19,954	66,155
Public Works „	4,560	50,258
Marine „	67	4,104
Telegraph „	20	737
Military „	1,098	8,080
Educational „	432	2,122
Forest „	952	4,306
Miscellaneous „	4,854	22,430
Road Cess Committees, &c., on payment ...	894	2,194
Workshops to complete repairs	575	1,377

Thus the total number of instruments issued was in excess of last year by more than 12,000, their value being Rs. 34,000 greater.

48. The average number of theodolites and levels issued annually during the previous three years ending 31st March 1883 was 96 for the former and 135 for the latter instruments. During the year under report the numbers were

respectively 103 and 100, of which one-third were instruments repaired and made serviceable from the stores of the office.

49. The number, class, and cost of the principal instruments purchased were as follows:—

	Number.	Value.
		Rs.
Compasses, magnetic, for plane-tables	40	240
Glasses, binocular	7	259
Levels, dumpy	1	260
Plane-tables, deal	370	2,590
Ditto stands	377	2,969
Pins for chains	9,300	869
Rules, sight, for plane-tables	375	1,125
Scales of various sorts	53	111
Squares, optical	100	750
Tapes, measuring	86	537

It will be seen on comparison with former years that there has been a considerable increase in the purchase of articles of country manufacture, such as plane-tables, sight-rules, &c., which were required to compensate for the decreased manufacturing powers of the workshop alluded to above.

50. The chief articles manufactured in the workshop and the cost of their manufacture were as under:—

	Number.	Value.
		Rs.
Apparatus for earthquake observation	1	600
Bars, standard, steel	6	190
Boards, drawing	48	645
Chains, measuring	671	5,725
Clinometers, survey pattern	50	1,440
Compasses, magnetic, for plane-tables	59	810
Glasses, tracing	5	293
Plane-tables	57	526
Pluviometers	32	440
Pins for chains	4,800	700
Rules, flat, ebonite	450	250
Do. for plane-tables, metal	14	262
Scales, ivory, offsets	851	386

51. The total number of instruments repaired in the workshop was 3,257, and the cost of the repairs Rs. 26,613. The principal instruments repaired were as follows, viz:—

Anemometers	8
Arithmometers	1
Barometers	63
Chains	160
Clinometers	15
Compasses, drawing	399
Ditto, magnetic	126
Ditto, prismatic	214
Ditto, surveying	107
Glasses, binocular	32
Heliographs, &c.	35
Hydrometers	35
Instrument boxes, 1st, 2nd, and 3rd sorts	39
Levels, dumpy, &c.	143
Machines, hand and map-printing	15
Plane-tables	41
Rules, flat, parallel, and sight	202
Range-finders	15
Squares, optical	139
Sextants	16
Stands for various instruments	390
Staves, levelling	139
Tapes	56
Telescopes	67
Theodolites	118
Thermometers	39

The number of theodolites and levels, which require the greatest care and good workmanship, was 261, being a small decrease from last year, when the number was exceptionally great. The system of local manufacture mentioned in paragraph 297 of last year's report was carried on with good results, careful inspection being made of all articles supplied.

52. The profit and loss account of the workshop shows a profit of Rs. 14, the charges having amounted to Rs. 51,208, whilst the work done was calculated at Rs. 51,222. This shows that the percentages for supervision and the prices charged for the work were very correct. The cost of the remaining portion of the establishment, including supervision, packing expenses, office accommodation, &c., was about Rs. 18,548, which may be considered as representing the expenses connected with the receipt and issue of about 69,491 instruments, valued at about Rs. 3,08,000.

THE TRIGONOMETRICAL BRANCH OFFICE.

DEHRA DU'N.

53. The principal work of this office is the final reduction and publication of the triangulation of all parts of India, including the principal and secondary operations of the Great Trigonometrical Survey, and also the publication of the Topographical Surveys executed by the Trigonometrical Branch of the Department, as well as by the Forest Survey Department. Most of the publications being necessarily of a technical nature, and the office being located at Dehra Dún, at a considerable distance from Calcutta, it has small drawing, photo-zincographing, and printing establishments of its own; it is thus independent of all extraneous assistance in publication, excepting as regards book-binding, which is done mostly at Calcutta and Roorkee. The office has also a depôt of instruments and stores attached to it, chiefly of the higher class of instruments appertaining to the Great Trigonometrical Survey, of which it was long the head-quarters office.

Personnel.

W. H. Cole, Esq., M.A., Offg. Deputy Superintendent, 3rd grade, in charge.

Computing Branch.

Mr. C. Wood, Surveyor, 1st grade.
„ H. W. Peychers, Surveyor, 3rd grade.
Baboo Ganga Pershad, Computer.
„ Caliy Mohun Ghose, Computer.
„ Kally Coomar Chatterji, Computer, and 10 other computers, &c.

Printing Branch.

Mr. B. V. Hughes, Printer.
12 Compositors and apprentices.

Correspondence, Stores, &c.

Mr. J. Bond, Offg. Surveyor, 4th grade.
2 Native writers.

Photo-zincographic Branch.

Mr. C. G. Ollenbach, Zincographer.
„ C. Dyson, Photographer.
2 Native draftsmen.
1 Do. Assistant draftsman.
1 Do. Map-keeper.

Drawing Branch.

Mr. G. W. E. Atkinson, Surveyor, 2nd grade.
Mr. H. Sindon & 5 other draftsmen.
19 Assistant draftsmen and map colorists.

Solar Photography.

Mr. L. H. Clarke, Surveyor, 2nd grade, Solar Photographer.
Mr. C. F. Guthrie, Assistant to ditto.

54. The final reduction and publication of the various operations of the Great Trigonometrical Survey have been proceeded with; but the progress has not been so great as could be desired, owing to much extraneous work having fallen on the computing branch. This consisted in the preparation of A—K's narrative of his explorations and tabular data for the press, and the reading of the proofs as they were printed; in the translation and preparation for the press of a report on Dardistan for the Foreign Office; in the equipment of the Afghan Boundary Survey Party, on which much time and labour were expended; and, lastly, in affording assistance to the two Astronomical Parties, besides minor duties.

55. The reduction of the astronomical latitude observations has continued to be carried on. It was at one time hoped that the actual calculations would have been completed under the able superintendence of the late Deputy Surveyor-General, Mr. Hennessey; but there is still a good deal to be done before the results can be prepared for publication.

56. A commencement has been made with the final reduction of the principal triangulation of the South-West Quadrilateral; but it is not intended to do more at present than can be accomplished by one pair of computers, because

Major Rogers reports most favourably on the services of Mr. T. Bolton, the Mathematical Instrument-maker, and of his Assistant Mr. F. Marshall; the Instrument Store-keeper has not altogether given satisfaction, but with this exception the store and office establishment have continued to work well.

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so much remains unfinished in connection with those quadrilaterals, of which the principal triangulation already stands reduced, especially in connection with the secondary triangulation. The synoptical volume of the Assam Longitudinal Series, comprising also the Assam Valley Series, and a considerable amount of secondary work, has been made ready for the press.

The remaining work performed by the Computing Branch is of a somewhat miscellaneous character, as will be seen by reference to the appendix.

57. As regards the publications of this office, those synoptical volumes—*i.e.*, volumes furnishing abstracts of trigonometrical data suitable for local wants—which were in the hands of the binder last year, have since been published, as have also volumes XIX, XX and XXI of the N. Párasnáth, N. Málúncha, the Calcutta and Brahmaputra Meridional, and the E. Calcutta Longitudinal and Eastern Frontier Series. A pamphlet of levels from False Point to Howrah has also been published.

The synoptical volume of the S. Pársanáth and S. Málúncha Series is nearly ready for the binder.

58. Of works in the press, there are the details of the principal triangulation of the Southern Trigon; the details of the Eastern Sind and Jodhpore Meridional Series; the Electro-Telegraphic Longitude operations of season 1881-82; the synoptical volume of the Assam Longitudinal Series; the spirit-levelled heights between Bombay, Madras and Karwar, and sundry other publications.

59. The time of the Drawing Office has been also much occupied with extraneous work; and the publication of the level charts—on which are shown the results of the levelling operations for canals, railways, and other public works, after having been connected with the main lines of levels of this survey and reduced to mean sea-level—has been impeded. Those sheets now in hand, of which some will very shortly be published, are Nos. 6 (2nd edition), 12 (3rd edition), 67, 81, 83 and 88. The importance of these charts is very great.

60. A revised map in 3 sheets of A—K's explorations, with an index showing a sketch of the Jángtháng, and also a plan of Lhása, was prepared and published; and maps for the use of the Afghan Boundary Commission were compiled and printed.

61. All the new maps received during the current year from the Guzerat and Cutch Parties were examined and published, as also several second editions of maps of Kattywar. For the Forest Survey Department, 14 maps were printed, and an ancient classic, called Janum Sakhi, a book of 460 pages in the Gurmukhi language, was reproduced for the Punjab Government.

62. The protection of the principal stations of the Great Trigonometrical Survey has been a subject of care as heretofore. There are now 3,590 stations in 339 districts on the lists. Of 317 district officers from whom annual reports were due, 68 failed to submit them.

63. Solar photographs for the Solar Physics Committee, South Kensington, have been taken throughout the year as directed by the Secretary of State for India. The sun was invisible on 78 days, and three other days were lost owing to the illness of the photographer.

64. The large photo-heliograph for taking sun-pictures, 12 inches in diameter, has not given satisfactory results. It has recently been reported on by a Committee, consisting of Colonel Haig, Major Waterhouse, and Mr. Cole, who have investigated the causes of failure, and have recommended that the object glass and enlarging lenses should be sent to England for examination, both as to their absolute powers and their relation to each other, which it is feared is faulty.*

* Mr. Cole makes special mention of Messrs. Wood, Atkinson, Peychers, Bond, and Baboo Ganga Pershad, and speaks favourably of the services rendered by Messrs. Clarke, Hughes, Ollenbach, Dyson, and Guthrie, and of Baboos Cally Mohan Ghose, Shivanath, and Shoshee Bhushan.

APPENDIX.

EXTRACTS

FROM

THE NARRATIVE REPORTS OF THE EXECUTIVE OFFICERS

IN CHARGE OF

THE SURVEY PARTIES AND OPERATIONS.

Extract from the Narrative Report of MR. A. D'SOUZA, *Surveyor, 1st grade, in charge Secondary Triangulation Party;—season* 1883-84.

THE station pillars and beacons which were built were made over to the village officials for safe custody, and receipts for them, in due form, were obtained.

Mr. Potter was engaged throughout the season on the approximate work, cutting rays, and building beacons and stations.

Locale. Coast of Orissa.

I had provided myself with a large wooden trestle (which I had constructed at the Jobra workshop at Cuttack) 12 feet in height, on which the usual instrument trestle could be placed for observations, thus giving me a height of 17 feet to make my observations from; and the signals were shown from a scaffolding 14 feet high, made of bamboos, over the station mark. Yet, with all these appliances, rays had to be cut in every case in order that the stations may be mutually visible. Ray, cutting in such a country as this is a most trying work, for not only is the country covered with dense jungle, consisting generally of tangled thorny bushes, bamboos, and the jungly date (*hartal*), but it is subject to the overflow of the tides, and is so swampy that the men had on several occasions to wade knee-deep in slush while engaged in cutting the rays. Numerous tidal creeks, dangerous to cross without a boat, and in many cases embanked so as to form deep permanent channels, added to our difficulties, and we were obliged to construct rafts to carry the men across—a course which entailed much waste of time, inasmuch as no ray took less than from 10 to 12 days to cut, and one at Jambu very nearly a month.

Sickness.—Although the country has the reputation of being very unhealthy, the party suffered but little from sickness. There was, however, one case of sporadic cholera at Jambu, to which the patient succumbed within 48 hours. Every precautionary measure was taken to prevent the disease spreading, and the party was removed as soon as possible to a more healthy part of the country. Three other men were attacked with the same disease in the railway train while on their way to their homes. One of these died at Benares, but the others recovered.

Description of country.—The country through which the survey operations were carried on is the coast of Orissa from Pooree to Balasore, about 170 miles in length and 3 miles in breadth, covering an area of about 510 square miles. This tract may be divided into three parts, as each has a distinct natural aspect which is very remarkable. The first is the coast line from Pooree to the mouth of the Devinadi. This tract, lying in the Pooree district, is an open, barren, sandy strip of land, having on one side a range of sand-hills of the average height of 30 feet skirting the sea-coast, and on the other rich arable lands.

There are two rivers which flow through it—one the Kusbhadra and the other the Nunnadi; the former a distributary of the Kaokye, from which it branches off at about 13 miles south of Cuttack, and flowing in a southerly direction enters the sea west of the Devinadi; the latter is a deep river, navigable by country boats, which passes by Telikud thana, and flowing parallel along the coast joins the western branch of the Devinadi before it debouches into the sea.

No difficulties of any kind were experienced in this portion of the work, as carts can be used everywhere, and provisions and labour were readily supplied by the zemindars through whose lands the triangulation was carried on.

The coast line from the mouth of the Devinadi to the Dhamra river, the greatest portion of which is in the Cuttack district, is very unhealthy and presented serious obstacles to the progress of the work, being covered with dense jungle and intersected with rivers and tidal creeks. It resembles the margins of the Sunderbuns bordering the sea-coast, which are subject to the overflow of the tides, and are notoriously malarious. This tract is almost destitute of inhabitants, and boats had to be resorted to as the only means of communication and carriage. Provisions and labour had to be procured from villages in the interior, in some instances many miles from our work, and building materials had to be brought from towns such as Pooree, Cuttack, and Balasore—chiefly by boats—the distance from any of them to the places where they were required often exceeding one hundred miles. Depôts were formed in different portions of the work, so that no time was lost in supplying the materials as they were wanted.

The third or remaining portion of the coast line from the mouth of the Dhamra to Balasore is a barren strip of salt waste (a few small muddy streams crossing it here and there, whose banks are fringed with mangrove jungle and subject in some places to the overflow of the spring tides): portions of this tract are taken up for the manufacture of salt. Carts and pack bullocks can be used here, but these are with difficulty obtained, as they are very much in demand for conveying grain to the different ports, and for the construction of the new canal from Charbatia to Midnapore.

Kanarak Temple or Black Pagoda.—One of the most noteworthy places in this tract is the temple at Kanarak $\frac{\text{Lat. } 20^{\circ}\ 53'\ 12''{\cdot}4}{\text{Long. } 86^{\circ}\ 6'\ 15''{\cdot}6}$. It is now in ruins and forms a conspicuous land-mark for coasting vessels. This ruined temple, known also as the black pagoda, is dedicated to Jagannath. There seem to have been two buildings, the outer and inner hall: of these, the former only remains; the other has been destroyed and lies in a heap of stones covered with trees and tangled creepers.

Rivers and estuaries.—Besides the Budhabalanga, on the bank of which is the town of Balasore, there are three noble estuaries by which the three great rivers, viz. the Dhamra, the Mahanadi, and the Devinadi, empty themselves into the sea. The Dhamra, with its branch the Maipara, is the largest river in Orissa. It receives the combined waters of four large rivers, the Baitarni, the Brahmini, the Kharsua, and the Matai, all of which are navigable to a certain extent by craft of 100 to 200 tons burden. The channel of the Dhamra is broad and deep, and is capable of admitting vessels of 500 tons burden up to Chandbali. Point Palmyras palm, an intersected point of the old triangulation, was formerly used as a land-mark by vessels entering the harbour, but it has been blown down. Two beacons have now been built here, one on Budara station of *pakæ* masonry 15 feet high, obelisk-shaped, a little south of the old position of the palm; the other a wooden cross of about 12 feet in height, embedded in a masonry pillar on Gordon island: both of these will be of great assistance to vessels making for the harbour. The beacon on Shortt's island, where it is proposed to build a light-house, has also been fixed by triangulation together with the buoys in the harbour. Passing close to the False Point light-house where it debouches into the sea, there is a sandy shoal across the mouth of the river Mahanadi through which a passage was made by the stream in 1863, and another in 1874, called the southern entrance, which is in a line with the direction of the course of the river as it leaves Barkud. The channel is deep and broad for a considerable way up, but the sand bar and heavy breakers at the mouth present serious difficulties to vessels entering it, though country and cargo boats and small river steamers do ply continually up and down, conveying grain and salt to the different marts, and to False Point harbour by the Barkud creek for shipment to other ports.

The Devinadi, a branch of the Kathjori, falls into the sea in $\frac{\text{Lat. } 19^\circ\ 51'}{\text{Long. } 86^\circ\ 29'}$. It is broad and deep for some considerable distance inland. This estuary would make an excellent harbour but for the shifting shoals and heavy surfs at the mouth. At about 10 miles from the mouth is a trading river port of some importance; and when the canal thereto from Cuttack is complete, I have no doubt it will form one of the principal trading centres of the district. From the Devinadi to False Point and from False Point to the Dhamra, there is a continuous waterway through tidal creeks and by canals.

Harbours.—There are six harbours on the coast between Pooree and Balasore, viz. False Point, Chandbali, Dhamra, Churaman, Laichanpur, and Balasore.

False Point harbour, $\frac{\text{Lat. } 20^\circ\ 24'}{\text{Long. } 86^\circ\ 49'}$, is, however, considered to be the best and safest on the coast. Although the capabilities of this port were known many years ago, it was not made much use of either by Government or the mercantile public till 1866. A port was then required for the importation of grain for the relief of the famine-stricken people of Orissa, when False Point harbour was found to be, not only a convenient, but a safe one for the purpose. Since the opening of the Kendrapara canal, by which direct communication was effected with Cuttack, a great impetus has been given to the trade in grain and other produce. The anchorage is commodious and well sheltered by Dowdeswell and Long islands, and vessels of large tonnage can anchor here in perfect security during all weathers. There are two channels that lead into the interior from the harbour—one by the Jambu river into the Kendrapara canal to Cuttack, the other by the Barkud creek into the Mahanadi to Butmundi. To the east of the harbour is the barren sandy Dowdeswell island, also called Hookey-tollah, about 5½ miles in length by about one thousand yards in breadth in its widest part, on which reside the Port and Custom House officers, and where there is also a traveller's bungalow, a refuge house, a tide gauge, and a post and telephone office. As there are no bazars on the island, supplies have to be brought from Jambu.

The place is unhealthy; all who have resided there for any length of time having suffered more or less from malarious fever. A settlement was formed some years ago at Jambu, on the mainland opposite to False Point harbour, where some very nice bungalows were built; but they have since been abandoned, and the community at present consists of a native merchant, engaged in exporting rice, and a small village of Coringies, who have settled down there. Besides the country rice sloops and vessels of heavier burden that call at this port, the British India Steam Navigation Company's steamers touch here every week and the Inland steamers twice a week.

False Point Light-house, $\frac{\text{Lat. } 20^\circ\ 19'}{\text{Long. } 86^\circ\ 45'}$, lies six miles south of the harbour.

Chandbali, $\frac{\text{Lat. } 20^\circ\ 46'\ 20''}{\text{Long. } 86^\circ\ 49'\ 0''}$, is on the left bank of the river Baitarni in the Balasore district. It is about 18 miles inland from the mouth of the river Dhamra. This town has risen to some importance only within the last few years, since the opening of the canal which connects it with Cuttack. There now reside there at present, besides a number of native traders and two European firms exporting grain and other country produce, a Sub-Collector and Port Officer, who is also a Magistrate. Three weekly steamers ply between this port and Calcutta, conveying merchandise and a large number of passengers to and fro, mostly pilgrims on their way to the famous Hindu shrine of Jagannath at Pooree, and domestic servants and palki bearers who resort to Calcutta in numbers in search of employment.

Dhamra, $\frac{\text{Lat. } 20^\circ\ 45'}{\text{Long. } 86^\circ\ 59'}$, is situated on the left bank and close to the mouth of the river Dhamra. It has a good and safe anchorage, but is not of much importance, as the trade of the country is taken up mostly by Chandbali, which is but a few miles up the river. A number of native craft call here for freight, which is chiefly rice. It is under the superintendence of the Port Officer of Chandbali and has also a Custom House officer.

Churaman, $\frac{\text{Lat. } 21^\circ\ 7'}{\text{Long. } 86^\circ\ 49'}$, is a small sea-port town on the Gammi river, about 26 miles north of the mouth of the Dhamra, and is under the supervision of the Port Officer of Chandbali.

It is reported to have been at one time one of the best trading ports on this side of Calcutta. The river has, however, silted up now, and vessels cannot enter it, but have to anchor 5 or 6 miles from the shore. The only vessels that are able to make the port are rice sloops of 200 tons burden or thereabouts. The canal connecting Charbatia with Midnapore, which is now being excavated, passes by this port as well as Laichanpur, and will soon transfer the entire trade to Oolaberiah on the Hooghly, as it is more accessible to vessels and steamers than either of these ports.

Laichanpur, $\frac{\text{Lat. } 21^\circ\ 15'}{\text{Long. } 87^\circ\ 25'}$, is 5 miles north of Churaman on the Kusban river. It is a small collection of temporary huts on the bank of a small muddy creek which is almost dry at low tide. The only vessels that are able to enter it are rice sloops, larger vessels having to anchor out 12 miles from shore. This port, like all the others on the coast, has been ruined by the common enemy silt, and it is now only accessible to a jolly boat by carefully watching the tides.

Balasoro, $\frac{\text{Lat. } 21^\circ\ 30'}{\text{Long. } 87^\circ\ 0'}$, is on the Budhabalanga river and about seven miles inland. The channel leading to the entrance of the river is obstructed by a sand bar which requires very careful navigation and watching the tides to get over it. Two steamers ply between this and Calcutta weekly: a very large trade is carried on here in the exportation of rice.

Extract from the Narrative Report of CAPTAIN J. R. HOBDAY, *Assistant Superintendent, Survey of India, in charge No. 4 Party, Andaman Topographical Survey;—season* 1883-84.

By Surveyor-General's Notification No. 187, dated 21st August 1883, I was appointed to the charge of this party.

The available datum on which to base the survey was the position of a point on Chatham Island in the harbour of Port Blair, the latitude and longitude of which had been determined astronomically in 1863 by Mr. Nicholson of the Great Trigonometrical Survey, so that in order to undertake a systematic triangulation it was necessary to measure a base line and determine an initial azimuth.

Commencement of field season.

The party arrived at Port Blair on the 27th November, and from that date till the 30th December we recorded 21·14 inches of rain, or an average of 0·62 inches per diem, so that we found the country in a very swampy state, the nature of the soil being such that, whether riding over the hills or in the valleys, our ponies sank into the mud up to their hocks, whenever an attempt was made to leave the metalled road. The valleys cleared of forest were studded with rice fields, on which the water did not dry up till the month of February.

Remarks on the country and inhabitants.

The whole of the islands, with the exception of the small cleared patches fringing the harbour of Port Blair, are covered with dense primeval forest. Some of the trees exceed 200 feet in height, and most of them grow perpendicularly up for about 100 feet before the branches commence. The Padouk is the most valuable tree found in these forests. The amount of undergrowth varies; in some parts it is found very thin, whereas elsewhere it is almost impenetrable.

Bamboo jungle is abundant in some parts, the reed being always hollow. There are two conspicuous ranges of hills in the South Andamans, one skirting the eastern coast, and the other running down the centre of the island as a sort of backbone. The highest point on the eastern range is known by the name of *Koyab* (red earth, with which the aborigines smear their bodies), 1,510 feet above sea-level, and *Cholunga* (spring), 1,057 feet elevation on the central range.

Creeks, with mangroves on either side drooping down to the water's edge, run for considerable distances into the interior of these islands. The northern portion of Rutland Island is very mountainous; Ford's Peak or Kala Pahar, the highest point, attaining an elevation of 1,426 feet.

The Andamanese are a race of Negritos, with very dark skins, of very small stature, but well made. There are said to be nine distinct tribes, each speaking a different dialect, and inhabiting the islands as follows:—

Aka-Chariar	...	North of North Andaman.
Aka-Jaro	...	South-east of North Andaman.
Aka-Kédé	...	South-west of North Andaman. Interior Island, and north-west of Middle Andaman.
Aka-Juwai	...	Centre and west of Middle Andaman.
Aka-Kawl	...	North-east of Middle Andaman.
Aka-Bojigyáb	...	Between Homfray's and Andaman Straits.
Aka-Balawa	...	Archipelago.
Aka-Bojigngiji	...	Eastern parts of South Andaman and north of Rutland Island.
Aka-Járawa	...	Little Andaman, North and South Sentinals, south-west and south of South Andaman, south of Rutland Island, Cinque Island, &c.

The tribe British rule has succeeded in training is known as the Bojigngiji in the immediate vicinity of Port Blair. Our relations also with the remaining tribes, with the exception

of the Járawas, are said to be on a friendly footing, especially with the Aka—Chariar, Jaro, Kédé, and Balawa; but nothing is known of the interior of these islands, and the information is generally of a very scanty and doubtful nature.

The Andamanese appear to be a wandering race, moving from place to place, building temporary shelters of a lean-to type, formed of a few branches or leaves, and living chiefly on pigs (the *sus Andamanensis*), fish, turtles, &c.

The Járawas, or Little Andamanese, have ever been openly hostile: they are in short professional wreckers, and within the last 15 years two or three expeditions have been sent to punish them for barbarities committed on ship-wrecked crews. Notwithstanding these castigations, they still hold aloof, and retain their reputation for treachery and cruelty. Of late years visits have been paid them annually by the Chief Commissioner, when presents have been given with a view to bring about a more amicable relationship. But their language is quite unintelligible, even to our tame Andamanese, and after accepting our presents, they have been known to come down and charge on the party when returning to the boats. On the occasion of our visit mentioned further on, several hundreds of them showed themselves on the beach in Hut Bay, on the east of the island. After taking the presents we deposited on the beach, they appeared sulky, and hid themselves in the forest, when it was thought expedient not to press them further, as they evidently meant mischief.

The Járawas, inhabiting the Little Andamans, appear to be a more populous tribe than those found in the other islands, and are thus supposed to have been the dominant tribe. They also build large, substantial, thatched huts, dome-shaped, at least 60 feet in diameter and 30 or 40 feet high. We landed and entered one of these huts on the north of the island when the occupants were absent, or had fled at the sight of the steamer.

I should fancy these huts afford shelter for about 30 or 40 people. The thatching is propped up by long poles, which are set up in three circles within the hut. Small cots were found on which they slept; also a rocking cradle. The cooking is evidently carried on inside the hut, and the eatables are slung up above. All round the interior of the hut, about 3 feet from the ground, were closely arranged pigs' skulls, trophies of the chase, beautifully cleaned and neatly bound up. It is believed that the Little Andamanese obtained the notion of building these dome-shaped huts from the Car Nicobarese; the only difference between the huts of the Nicobarese and Little Andamanese being that, whereas the former are built on piles, the latter rest on the ground.

The hostile Andamanese, who inhabit the western and southern portions of the South Andaman, are also termed Járawas, and it is surmised, though not yet satisfactorily proved, that they are identical with the tribe inhabiting the Little Andaman, having migrated northward by the Brothers, Sisters, Rutland Island, &c., &c.

Whilst the station of Cholunga was being cleared under the superintendence of Mr. Campbell, some of these Járawas laid an ambush on the track that had been cut between the camp and the station. When the clearing party arrived at the spot, a flight of arrows was suddenly discharged from a very close distance at the leading man, who happened to be a Pathan sepoy belonging to the police force at Port Blair. One arrow pierced his back near one shoulder blade, the head of the arrow re-appearing close to the other. Shots were fired, but without any apparent result, the enemy having fled down the slopes of the hill into the forest. Punitive expeditions were organized the day after, and one party came across the colony of Járawas to the west of the central range, when a man and boy were captured, one of our tame Andamanese having put an arrow into the man's thigh.

After treatment for some months at the hospital, the Járawa at length recovered, but I have since heard that he has succeeded in effecting his escape.

Some self-supporting convicts were also killed by the Járawas in the south of the South Andaman Island, within a few miles of the settlement, but it is a very difficult matter to catch, or even trace, them in these forests. The arrows of the Andamanese have broad, diamond-shaped heads, made of iron, with barbs. Thus an arrow wound is generally a very ugly one. The arrow heads of the little Andamanese are made of tough wood, well pointed.

Survey of the volcano of Narcondam and Barren Island.

At the end of January, Mr. F. R. Mallet, Deputy Superintendent, Geological Survey, arrived in Port Blair to investigate the mineral resources of the Andamans. It was supposed that a workable supply of sulphur might be found on the volcano of Barren Island, and an expedition was accordingly planned in order to ascertain the quantity and quality of that substance in deposit.

I took the advantage of accompanying this expedition, which started at night on the 2nd February in the S. S. *Celerity*. We arrived the following day, and after much difficulty, owing to the heavy sea then running, managed to effect a landing on a small beach situated on the west of the island, where there is a breach in the outer crater, which allows the comparatively recent lava from the inner cone to flow into the sea. On the beach we discovered a hot spring, the temperature of the water being about 115° Fahrenheit. The water was decidedly brackish, but drinkable when placed in vessels and allowed to cool during the night.

Mr. Mallet and myself pitched our camp on a small hillock of ash, close to the landing place, and the same afternoon I managed to measure a base line with the crinoline wire chain, on which the subsequent survey of the island depended. We remained on the island till the 8th February, by which time I completed the survey of the interior. An attempt to run a circuit round the coast with the crinoline wire proved unsuccessful. One of the ship's officers and myself started off in a Rob Roy canoe with one end of the crinoline wire, when a large shark came up to the surface of the water in unpleasant proximity to the

PLAN OF INNER CRATER

THE VOLCANO OF BARREN ISLAND BAY OF BENGAL

Approx. Lat. 12°-15'-N.
Long. 93°-50'-E.

Scale 4 Inches = 1 Mile.

Area 3·07 Sq. Miles.

Surveyed under the direction of Colonel G. C. De Prée, Surveyor General of India, by Captain J. R. Hobday, S.C.;
Hill Shading by Captain J. R. Hobday, S.C.; Names, &c., Typed at the Survey of India Offices.

Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S.C., Surveyor General of India.

Survey of India Offices, Calcutta, February
1885.

NOTE.—Surveyed on the scale of 8 Inches = 1 Mile and reduced by Photography to 4 Inches = 1 Mile.

THE VOLCANIC ISLAND OF NARCONDAM BAY OF BENGAL

Approx. Lat. 13°-26'-N.
Long. 94°-16'-E.

Scale 4 Inches = 1 Mile.

Area 3·26 Sq. Miles.

Surveyed under the direction of Colonel G. C. Depree, Surveyor General of India, by Captain J. R. Hobday, R.E.;
Hill shading by Captain J. R. Hobday, R.E., Names, &c., Typed at the Survey of India Office.

Photo-zincographed at the Survey of India Office, Calcutta.

Published under the direction of Colonel G. C. De Prée, S.C., *Surveyor General of India.*

Survey of India Office, Calcutta. February 1885

NOTE.—Surveyed on the scale of 8 Inches = 1 Mile and reduced by Photography to 4 Inches = 1 Mile.

canoe, causing us to paddle back: in the meanwhile the wire had sunk, and getting entangled with the coral below, snapped.

We returned to Port Blair on the 9th February, and organized another expedition to the island of Narcondam, situated about 75 miles north-north-east of Barren Island. We started at midnight of the 11th February, arriving the following day. After steaming round the island we found an anchorage close into shore near a small rocky eminence on the north-west coast. About 3 P.M. the same afternoon, Mr. Black, one of the ship's officers, and myself, started to ascend the mountain; after cutting our way through dense undergrowth, and clambering over enormous boulders of rock, we at length gained the summit, just at sunset, and fixed a flag on a tree. When the moon arose we attempted to descend, but after advancing some dozen paces found it quite impracticable owing to the deep chasms between the boulders of rock: so nothing was left to us but to bivouac on the rocks, without food or drink. During the night the thermometer read as low as 64°, and owing to the heavy dew we were often compelled to dry our clothes before a fire we had lit. An aneroid barometer gave us 2,320 feet as the height of the summit above sea-level, which agreed within 10 feet of the computed value afterwards obtained by measured base. I believe we were the first Europeans who had ever succeeded in gaining the summit. A Mr. Ball of the Geological Survey made the attempt some years ago, but after three hours' clambering was forced to retire.

During the next two days I succeeded in completing an omnimeter traverse round the island, in order to define the coast line. The instrument was set up on outlying rocks, and the interior details of the island sketched in on a plane-table as we proceeded; the computation of the distances being conducted in a boat, in which we were pulled from station to station.

On the evening of the 15th February we started for Barren Island, arriving the following morning. In two days I completed an omnimeter traverse round the coast in the same manner as before explained. Without this instrument it would have been impossible to plot, with any degree of accuracy, the coast line of these islands, which consists for the most part of precipitous, inaccessible cliffs, running down to the water's edge. We were also fortunate as regards weather, for with any sea on this method would not have availed. One day there was a slight swell on the ocean, when it was found that getting the instrument on to the rocks, and then observing whilst the sea occasionally dashed up and washed over ones legs, kept the observer constantly on the *qui vive*. My best thanks are due to Mr. Black, the chief officer of the *Celerity*, who took a great interest in the work, and who, paddling on in a private canoe, acted as my forward man with the 10-foot pole.

We left Barren Island on the evening of the 15th February, arriving at Port Blair at daybreak the following morning. The two islands were surveyed on a scale of eight inches to the mile, and the maps when published will, it is to be hoped, possess a peculiar interest both from a geological and geographical point of view. For want of time and means, the positions of these islands were not determined astronomically, nor were the Andamans ever visible from their summits; but as far as we were able to deduce from observations with the ship's sextants and chronometers, their positions as denoted on the marine charts are approximately correct. It is hoped that their positions will be more accurately determined during the ensuing field season, when the Andaman triangulation is extended northwards.

Barren Island is situated in the Bay of Bengal in approximate latitude 12° 16′ north and longitude 93° 50′ east. The total area of the island is 3·07 square miles: it is circular in shape, the greatest length being about two miles in a north-north-easterly direction. The main crater is in the form of an ellipse, whose major axis in a north-north-easterly direction is 1¼ miles, and minor axis one mile. In the centre rises a cone to an elevation of 1,015 feet above sea-level. The base of this cone is about 300 feet to the east, and to the west 100 feet above sea-level. The walls of the main crater are from 700 to 800 feet elevation on the north, and increase to about 1,150 feet to the south. The slopes of the central cone vary from 32° to 34°; fine volcanic ash lies on the surface, rendering the ascent a laborious undertaking. The same loose volcanic ash lies to some depth on the summit and slopes off the northern part of the main crater, as well as on its summit to the south. A small crater exists on the top of the cone, also elliptical in shape; major axis 300 feet and minor axis 190 feet; greatest depth 74 feet from summit. When looking at the island from the west, two small knobs of equal height rise, forming the north and south walls of the small crater on the cone: between these a rock of lava is plainly visible, as shown in the margin. Steam or smoke was issuing from the northern knob.

When digging for sulphur on the summit of the cone we found the temperature of the rocks, &c., very high, the heat being felt through our boots. There was evidence of three distinct outbursts of lava from the sides of the cone, situated at about one-third to half the distance down the slopes: one to the north, another to the east, and a third to the south. The most recent and extensive flow emanated from the outlet to the north. Sulphur was found deposited on the northern knob above quoted, and a greater quantity near the exit of the lava flow on the slope to the north.

The comparatively recent lava emanating from these lateral vents lies around the base of the cone, and extends as far as the water's edge on the west of the island, presenting the appearance of loose cinders or scoriæ of various sizes, heaped together in confused masses.

The main crater is formed of old lava, its outer slopes being covered with thick vegetation, the principal tree being a species of fig. South-west of the cone, and between the recent lava and the inner slopes of the main crater was found a short tongue of alluvial soil, on which grass was growing to a height of 2 or 3 feet. A similar tract of smaller dimensions occurs to the north-east. There is a good anchorage to the south-west of the island, opposite a narrow line of beach. The island appears to be infested with rats from foot to summit. They show themselves in great numbers at dusk, and even during daylight. Not being accustomed to the presence of man, they appear almost tame, and can easily be knocked over with a stick. A specimen was caught and sent to the Calcutta Museum, but I have not heard whether it has been classified as a distinct species. Bats and large crabs were found on the summit of the outer crater. The beautiful Nicobar pigeon, with white plumage and black points, was also seen both on Barren Island and Narcondam. I am told these pigeons are not to be found on the Andamans.

By constructing an elevation from the plan of the island, and continuing the outer slopes of the main crater, it is found that the lines meet in a point immediately above the present flue of the cone, by which it is conjectured that at some remote period the shape of the island was almost that of a perfect cone, and that its height was about double that of the existing cone above sea-level, after which a prodigious eruption is supposed to have taken place, blowing off the upper portion of the cone and leaving the present truncated crater; the existing central cone having generated since in the usual manner from successive overflows of lava and ash.

The volcano is known to have been in an active state at the close of the last, and beginning of the present century, but beyond this no records are, I believe, at hand by which its age can be determined. The temperature of the water issuing from the hot spring above mentioned is considerably lower than that given by explorers who have previously visited the island, by which it is inferred that the volcano is rapidly cooling.

The island of Narcondam is situated approximately in latitude 13° 26′ north and longitude 94° 16′ east. The total area of the island is 2·78 square miles; it is almond-shaped, its greatest length in a north-easterly direction being 2½ miles and greatest breadth 1½ miles. Its general appearance is that of a lofty conical mountain, 2,330 feet above sea-level, and covered with dense forest. The whole island is composed of trachytic lava, which lies in huge boulders on the steep slopes near the summit. No trace, however, of a crater was anywhere found, by which it is assumed that the island was merely thrown up by some violent convulsion of nature at some very remote period.

Flocks of hornbills, or toucans, uttering a peculiar shrill note, followed us during our ascent and descent. A large iguana or lizard with long prehensile claws, was captured, and now adorns the Calcutta Museum; and numerous Nicobar pigeons were also seen flying about the rocks, close to the anchorage. No water was found on the island, not an uncommon failing in volcanic regions, owing to the porous nature of igneous rocks.

The currents running round these islands are very strong, and the soundings very deep. Fish seem to be very plentiful. A sort of rock-fish, coloured green and blue, and beautifully marked, was caught off Barren Island, weighing 90lb, and measuring 4 feet 4 inches in length, 8 inches broad, and 20 inches in depth. Off Narcondam an enormous black skate of unprepossessing appearance, and generally known by the name of Devil-fish, appears to be very plentiful. Some rare orchids were also found on Narcondam.

In the meanwhile the South Andaman Island triangulation was progressing under Messrs. Keating and Campbell, but on account of the denseness of the forest, the gigantic proportions of the trees, and the peculiar difficulties connected with convict labour, the progress was slow.

On the 25th February the station steamer *Celerity* left for Calcutta, and was finally sent to Bombay and sold. The *Quangtung* was sent to take her place, but did not arrive in Port Blair till the 10th April, so that it was impossible to make any protracted expeditions by sea in the two steam launches, which are only intended for harbour purposes, and which, moreover, are constantly breaking down through defective machinery, &c. On the 18th April, the Chief Commissioner, Colonel Cadell, v.c., started on an expedition to the Little Andaman Island, and with a view to extend the triangulation southwards, if possible, I accompanied the party. We landed on the Brothers, then steered across to the South Sentinel, then back again to the north of the Little Andaman, and finally steamed completely round that island. We rowed up two creeks on the north and one on the west of the island, leaving presents in the canoes of the savages.

All these islands are very flat, and covered with thick forest growth. On the Brothers we found innumerable pigeons of lovely plumage, one beautiful bird with long, bronze hackles; also the Nicobar and Imperial pigeons. From the South Sentinel we took away specimens of the Burgos Latro, an uncommon and large crab. On the return journey we landed on the Two Sisters, arriving at Port Blair on the 23rd February. Owing to the short time we were able to spend on the islands, and the main object of the expedition being to offer friendly overtures to the Little Andamanese, I was only able to complete a rough reconnaissance, fixing the positions of the islands and the general run of the main creeks in the Little Andaman.

The Chief Commissioner left in the *Quangtung* for the Nicobar Island on the 27th April, returning on the 10th May, on which date the monsoon commenced.

On Messrs. Keating and Campbell completing the triangulation allotted to them, they were deputed to plane-table in order to complete the detail survey of sheet 14.

From the 26th to the 30th April I succeeded in completing my observations for the azimuth of Chatham Island, G. T. S., the weather being favourable. Observations were taken with a 14″ transit instrument on four zeros to two circumpolar stars at maximum elongation, one elongating east, and the other west of the meridian. The resulting azimuth, as deduced during the recess from the means of both elongations, gives a difference of only 0·1 second.

Extract from the Narrative Report of Lieutenant-Colonel R. G. Woodthorpe, r.e., *Officiating Deputy Superintendent, Survey of India, in charge No. 6 Party, North-East Frontier Topographical Survey;—season* 1883-84.

The original programme of this party was to explore the extreme north-east corner of Assam, including the sources of the Noa Dehing and the Patkai range; but as we were proceeding to our destination, news of the Aka raid on Balipara was received, and in accordance with the wishes of the Chief Commissioner of Assam, we arrested our steps at Tezpur to await the course of events. When the military expedition to rescue the captive Babus carried off by the Akas was decided on, we received orders to join the force proceeding into the hills.

While waiting for the expedition to be organized, we employed ourselves in observing from the three great trigonometrical stations, Singri, Sildubi, and Kamakia, and in clearing and observing from two points on a low range in our own territory, called the Guinuja and Sonai hills. From all these we were able to fix a few points and identify others already fixed, and also to do a little preliminary sketching to help us when the advance took place. We had a large establishment of coolies with us, engaged for the Singpho exploration work; but under the altered circumstances we did not require them all, so when Mr. Elliott considered that it was necessary that an advance should be made before all the transport and commissariat arrangements had been completed, I was able to place 150 coolies at the disposal of the military authorities, and a start was made from Dirju Mukh on the 17th December. This advanced force was under the command of Major Beresford, 43rd Assam Light Infantry. The morning was wet, and we were all soaked through very shortly: the afternoon, however, was bright, and we pitched camp in a fairly open spot, just within the hills, on the banks of the Dirju, up which our path lay. Here cholera attacked our party, and we lost several coolies and two klassies within 24 hours. We continued our journey on the 18th; but cholera accompanied us, and we did not get rid of it for several days. It demoralized our coolies, and much as the Mikirs dreaded the Akas, they dreaded the cholera still more, and on the 23rd, at the Maj Bhoroli, fifteen decamped, and were no more seen. We reached the Maj Bhoroli (*Maj*, Assamese, for "middle" portion, this part being the middle link of the big bends made by the Bhoroli in the hills) on the 19th. Here the stream is from 60 to 80 yards wide and very deep, with a swift current and strong rapids occurring frequently.

This river detained us on its south bank for several days making rafts on which to cross the camp. On the 23rd we were all across, and that night the Akas attacked us in force; they were beaten off, and on the 26th we advanced again. On the 27th we descended to the Tenga river, and found the Akas in great force, drawn up to oppose our passage. As our supplies were running short, and we were at some distance from our reinforcements, Major Beresford fell back to our last camp, only ¾ mile from the Tenga and about 1,300 feet above it. There we received orders from General Sale Hill to carry on reconnaissances only till he himself should arrive from Dirju Mukh with two mountain guns. General Hill arrived on the 5th January, and till that date we employed ourselves in doing what work we could in the neighbourhood of the camp, and with reconnoitring parties, and from a point on the road where it crossed the ridge between the Bhoroli and Tenga rivers. There was here a natural clearing which we enlarged, and from this point, which was on the edge of a deep precipice, and commanded an extensive view from south-east round by south to south-west, we did a good deal of work, and established heliographic communication with Dirju Mukh and Maj Bhoroli camps. Mr. Ogle's knowledge of military signalling, which he acquired in his leisure hours in Shillong in 1882 when a class was formed there, here proved of the greatest service, and enabled him to supervise the native signallers who always accompanied us. Mr. Ogle also displayed great skill in the construction of stockades, in which he materially assisted Major Beresford.

The passage of the Tenga river was forced on the 8th January, and from that date to the 23rd January, when the evacuation of the country was commenced, we were stationed at Labi's village. We visited and cleared two points on the high ridge to the north of Mehdi's and Labi's villages, whence we obtained a widely extended view of the country lying between us and the lofty snowy peaks of Tibet. Military considerations did not allow of our visiting much of the Aka country, or we might in a few days have very largely increased our topographical knowledge. When we left the hills, a small force under Major Beresford took an alternative route from Labi's village to Dirju Mukh, keeping entirely on the right bank of the Bhoroli river. This was found to be a better route on the whole than the one adopted for the advance. I was suffering from the sting of some insect, which lamed me, and I was unable to accompany Major Beresford, but Mr. Ogle went with him, and did some very good work. I returned by the way we had gone with the rear guard. While we were in the hills, Mr. Ewing had cleared Natkari, which I subsequently visited, and had surveyed as much as he

could of the country as far as Maj Bhoroli, on the half-inch scale. Shah Nasirudin and Mahomed Hossein had been employed in traversing various new roads, boundaries, &c., of which the Chief Commissioner wished to have records. We all met again at Dirju Mukh on the 28th January.

Mr. Ogle and I returned to Balipara on the 29th January, leaving Mr. Ewing to carry on the survey of the low hills at the head of the Mansiri river, while the two sub-surveyors continued their work in the plains.

Our work in the Aka hills being now at an end, it behoved me to consider what would be the best way to employ ourselves for the remainder of the season. Just before leaving Labi's village, Mr. Elliott had sent me a rough sketch map showing generally the route taken by a tea-planter, Mr. W. Penny, when on a visit in the previous month to some Daphla villages lying just between that portion of the Daphla hills surveyed by Colonel Godwin-Austen's party in 1874-75 and the Aka hills just surveyed by us. Mr. Penny, during his adventurous journey, had been very well received by all the Daphlas, many of whom he knew well, having had commercial transactions with them on occasions when they visited the plains to sell rubber, and I at once saw an opening for furthering our knowledge of these hills and filling up some important gaps in our map of Assam. I therefore communicated with the Chief Commissioner, and after consulting with him and with Mr. Penny it was finally arranged that Mr. Penny should accompany Mr. Ogle and myself with a small party into these hills; and some influential Daphlas, who were with Mr. Penny when I first visited him, assured him of their willingness to take us up to their villages. At my request the Chief Commissioner further procured the services of Dr. D. St. J. Grant, a young, clever, and energetic Surgeon, who had accompanied the advance under Major Beresford, into the Aka Hills. Apart from the great advantage and relief to us to have a skilled medical officer with us, I knew how acceptable his services would often prove to the people we were going amongst.

While sanction was being obtained for this expedition, and all the necessary arrangements were being made, I went down to Udalguri with Messrs. Ogle and Ewing to see if it were possible for the latter to be usefully employed in sketching the outer Bhutan hills. We visited the winter settlement of the Bhutias at Shergaon, about three miles above the Doimari stockade, and I am of opinion that a good deal of useful work might be done by clearing some of the higher peaks along the outer ranges. These peaks vary from 9,000 to 11,000 feet in height above sea-level, and would not be very difficult to reach from the plains, as far as I can see. The Bhutias, I imagine, might easily be induced to consent to this; and I do not think they would object to our penetrating even further. A good deal might be done without consulting them at all; the hills are quite uninhabited, and as the paths by Doimari and Amratut are the only beaten tracks from their hills, the Bhutias would probably never know that anything was being done. Those we questioned at Shergaon were not at all reticent about the paths and passes into their country, and gave us a good deal of, I believe, perfectly reliable information. Unfortunately we were not then prepared to visit a hill a little way above their settlements, from which we thought a good view could be obtained, but they expressed perfect willingness to let us go there. Had we known what we could do earlier, so as to make proper arrangements, I have no doubt Mr. Ewing could have done some valuable work; but as he was restricted to working from the plains and from the very low hills within our own boundary line, he was unable to accomplish very much in the month that remained to him, and the weather, moreover, was very unfavourable, the clouds seldom lifting from the mountain tops and obscuring all details beneath them. While we were in the Daphla hills, sub-surveyors Shah Nasirudin and Mahomed Hossein were employed on route and river surveys, and on such half-inch work as they could do without crossing the border.

On the 23rd February the party named in the margin left Balipara for Dibru Mukh, where they were joined on the 28th by Mr. Penny, and on the 29th we all commenced our march into the hills, leaving a naik and six of the Frontier Police in charge of a depôt of provisions at Dibru Mukh. From sickness and hardships, our coolie establishment had become very much reduced in numbers, and we were obliged to travel very light indeed, lighter even than during the Aka expedition. We had no tents; but for the officers a small "lean to" was constructed every evening and roofed with a water-proof sheet, and under this we spread our beds side by side, a pleasant enough arrangement in fine weather, but somewhat uncomfortable when it rains, which it did a good deal both night and day. The sepoys and coolies all hutted themselves roughly.

Lieutenant-Colonel Woodthorpe, R.E.
Mr. M. J. Ogle.
Dr. D. St. J. Grant.
1 Jemadar ... } 43rd A. L. I.
20 Rank and file ... }
1 Subadar ... } Frontier Police.
20 Rank and file ... }

Our first march was a very rough one, over big boulders along the banks of the Bor Dikrai, a fine fishing stream, through which we had to wade five times nearly waist-deep. We encamped on its banks, and next day, painfully, in heavy rain, which made the path very slippery, ascended a steep and lofty ridge on which we had to encamp away from any water. Fortunately Mr. Penny knew and had warned us of this, and we had provided to a certain extent for it. The next day's march was still more trying, a succession of ups and downs (sometimes as much as 1,300 feet at a stretch) along this ridge, and a final long and very steep descent to a little stream where we bivouacked. The advanced guard only reached this spot at nightfall, and most of the coolies and escort did not arrive till the next morning, when we moved on a short distance to the Bor Dikrai, allowing every one a little time to rest and refresh in a pleasant spot after the hardships and exertions of the past three days. On the 4th of March a long climb and a steep descent brought us to the pretty little Passu

stream, crossing which, and ascending the opposite hill, we found ourselves, late in the afternoon, at the first villages of the Tagen Abors. Here we were well received, and we encamped for the night in the fields close by: the next morning Dr. Grant had many applicants for relief, and disposed of all cases which could be treated simply and quickly, while Mr. Ogle and I went up above to a new clearance to determine our whereabouts. The dense jungle, through which our path had run hitherto, had prevented our seeing very much, and our want of carriage for provisions had prevented our remaining anywhere to make clearances, and we had not done much work up to the time of our arrival at these villages, situated advantageously on a promontory running out from the main range to the north into a curious, flatly open valley, an unusual feature in this country, of steep hills and narrow confined valleys. I had, fortunately, one evening, from the signalling station above the Maj Bhoroli, by the light of the afternoon sun, just caught a glimpse between the intervening hills of these Tagen Abor fields, and had taken a plane-table ray to them. We had thus a check for our position in latitude, and a trigonometrically fixed peak nearly due south gave us another for longitude, and enabled us to fix our position; we could then do a large amount of sketching and laid a good foundation for our work in advance.

On the 5th we advanced into the "Miri Pothar," so called, I am told, from the fact that under the oppressive rule of the Assam Rajas some Miris migrated to this fertile valley from the plains. This valley is long, flat, and open, another surprise in these hills. It is very swampy, and the villages and cultivation occur principally on the slopes just rising out of the plain on either side of the populous valley through which runs, with many a curve, the Papu river, its banks fringed with castor-oil plants. We encamped under the village of Badri, a very influential Daphla, and the next day moved down to the Papu river. We passed through the village *en route*, and a point above it afforded an excellent view of almost the entire valley; and while Dr. Grant treated the sick with medicine and entertained the whole with musical-boxes, &c., Mr. Ogle and I did a large amount of sketching, or rather Mr. Ogle did the sketching, I merely looking on and assisting him with "guesses at truth." The weather was so exceedingly cloudy and dull that it was very difficult to determine the direction of some of the smaller valleys. A comparison of our different views, and a discussion thereon, generally, however, resulted, I believe, in settling the question with a very fair degree of accuracy. On the 7th we halted, as our supplies needed replenishing, and without halting we could not expect to get in anything from the village. The halt was productive of much good owing to Mr. Penny's exertions and powers of bargaining; and on the 8th we resumed our onward march and reached the Kameng river, the easterly branch of the Bhoroli, on the 9th. Here we were detained for a few days making rafts whereon to cross this wide stream, 60 yards broad here, with strong currents, and receiving visits from chiefs on the other side. The Daphlas who had taken us to the Kameng were anxious that we should not cross, naturally wishing to divide all the presents we had brought, among themselves. Thanks, however, to Mr. Penny's experience and skilfull treatment of these trans-Kameng chiefs, we were ultimately able to make several excursions across the river, and do as much as the very bad weather would allow. It was most unfortunate that we had no clear weather just then, as we were quite unable to form any idea of the geography of the country around the upper course of the Kameng. Had we not been pressed either for time or provisions, and had the time of year been earlier, I believe we might have penetrated much further than, under the circumstances, we were able to do. On the 14th March we visited the village of Sin kole, the principal chief across the Kameng, and did a good slice of work; and on the 15th, our supplies being nearly at an end, and not sufficient being forthcoming from the villages to justify our further stay in the hills, we turned our faces towards Assam again. We travelled back along nearly the same route as that by which we had gone into the hills, and our increased knowledge of the country enabled us to fill in many important gaps which we had been obliged to pass over during our hurried advance. We reached Dibru Mukh again on the 22nd, not having an ounce of provisions left when we reached our godown; and on the 24th we were once more at Balipara, having been out of all communication with the great world beyond the Daphla hills for just one month.

Mr. Ewing finished what he was able to do early in April, and by the middle of that month the whole party was back in Shillong, with the exception of Mahomed Hossein, who had been deputed for some work in Dehra-Dún.

All through the season we had been unfortunate in the weather, which seems to have been much the same as was experienced in the Daphla Expedition in 1874-75 and as Lieutenant Harman and I encountered in the Miri hills in 1877-78, which leads me to imagine that on the north bank of the Brahmaputra, in Assam, the winter season is never one of uninterrupted sunshine, and that after November the higher ranges are seldom free from cloud or rain. This state of things is especially annoying when, as in the Aka and Daphla hills last season, every moment is of importance, and the Surveyor cannot afford to wait anywhere till the weather clears.

Our visit to the Daphla hills gave us important information about a branch of the Bhoroli river, namely the Kameng, of the existence of which no one had ever previously dreamed. This is a large stream, by far, I should imagine, the larger of the two feeders of the Bhoroli, and in order to assign it a sufficient drainage area to account for its volume it will be necessary to restrict considerably that hitherto assigned to the Khru. Had the weather been clearer when we were working on the Kameng, we might possibly

have been able to mark with some definiteness the actual position of the water-parting between the Kameng and the Khru.

Triangulation.

From the foregoing remarks it will have been gathered that the amount of triangulation done was exceedingly small; indeed, the number of points fixed in previous seasons rendered work of that sort almost unnecessary, even if it had not been rendered impossible by the weather and the conditions under which we were obliged to work.

Concerning the Daphlas, I have little to add to the able reports of Colonel Godwin-Austen and Lieutenant Harman in 1874-75, though it is necessary to state that confusion seems then to have existed in the public mind as to the proper application of the terms "Abor" and "Dapla," and it is necessary in reading these reports to substitute Abors for Daphlas and *vice versâ*: for instance, where it is said that "the Daphlas always tattoo, but the Abors never," just the reverse is the case. The Daphlas never tatoo, the Abors generally do, though Mr. Penny told us the custom is gradually dying out. It seems to have been really with an "Abor" chief and not with a "Daphla" that we had our quarrel in 1874-75. However, the right men appear to have been settled with, so it mattered little what we called them. "What's in a name," Shakespeare asks, adding—"a rose by any other name would smell as sweet;" and no doubt our "Abor" enemy got quite as much out of us, and was every whit as satisfied with the results of the expedition as if we had never called him a Daphla. There is this much to be said, that "Abor" is a very vague term, and among the Assamese, as I have often before pointed out, means only a "foreigner." It is a term applied equally to tribes in the Aka, Daphla, Miri, Mishmi, and Naga Hills, and acknowledged by the so-called Abors themselves only out of deference to the ignorance of those applying the term to them, and who, as they know, would fail to recognize them under any other name.

Extract from the Narrative Report of MR. T. E. M. CLAUDIUS, *Surveyor, 4th grade, Officiating in charge No.* 3 *Party, Baluchistan Topographical Survey;—season* 1883-84.

Remarks on the country triangulated and plane-tabled.

THE country triangulated and plane-tabled has on various occasions been traversed by others and reported on previously, so that it is needless to recapitulate what has already been ably described. But a few remarks on the Kachi or desert country may prove interesting. Being an immense expanse of all but treeless waste, it was with difficulty that triangulation could be carried on. The refraction and mirage were sufficient in themselves to delude even the most experienced. Objects invisible at one moment would at the next be seen far above the eye of the spectator, and it was only after a little training in such ground that the triangulator, watching his opportunity, would be able to take horizontal readings to a signal which at other moments it would simply be impossible to observe. The soil of the Kachi, however, is excellent, composed as it is of loam, and where the inhabitants after strenuous efforts have been able to irrigate the land, the cereals that spring up are most excellent in quality, far exceeding in size and substance those of the same species grown even in favourable localities of India. Water is, however, extremely scarce, and the inhabitants in most cases are obliged either to cart or convey it from a distance of 15 to 25 miles to supply the wants of their households. But as peace is gradually settling over the land of Baluchistan, more especially over that portion which has been assigned to the care and direction of the Government, but which previously was the most lawless and turbulent, the lowlands of Kachi are commencing to be thickly studded with hamlets, numerous wells are being sunk, and once again the people can boast of immense herds of cattle without the dread that at any moment they may be snatched away by the daring and inexorable raiders of the Marri and Bugti hills. The lowlanders are all tall and robust in stature. Longevity with them seems to be the rule, and in one instance a Patriarch was seen at the village of Dhinar, who had with him his lineal issue of the fourth generation.

The hilly ground plane-tabled was generally in no respect very remarkable. The main ranges, such as the Bambhor and Dunghan, are composed of limestone, while the other surrounding features comprise rolling sandstone. Markhor and Oorial are the only fauna which thrive on these arid and desolate hills.

The petroleum springs, which are in existence near the hill of Mourani in the Marri hills, are most important, as the supply has been pronounced to be unlimited by Mr. Townsend, who analysed and examined them on the part of Government last winter. The following is from notes by Mr. Copping, whose triangulation embraced the whole of the Bugti Dera territory, and which is nearly all of a hilly and broken nature, ranging in height from 300 feet near Dhrinak to about 6,000 feet on the Siah Koh mountain. There were only three permanent settlements met with. Bugti Dera, the chief town of the Bugtis, in the valley of the Sehaf river, is pleasantly situated near the source of that stream in a broad expanse of cultivation, and is about 1,800 feet above sea level, where the climate is temperate all the year round, the lowest reading recorded by the thermometer in February, the coldest month in winter, being 56° Fahrenheit. The water is conveyed to the place by artificial channels from the hills to the north-east, and is always abundant and good, from a spring near a shrine dedicated to Suri Pir; at its exit from the hillside it always maintains a temperature of 72° Fahrenheit. Loti, another fixed settlement, lies about eighteen miles to east-south-east of Bugti Dera, with which it is connected by a very good road, first made by the troops comprising Wilkinson's Brigade in

their passage through the country during the late Afghan campaign, and is still kept in fair order by the Bugtis, as it is a portion of the principal trade route which traverses their territory from Rojhan in the plains of Sind on the east, to Lohri in the Kachi at the foot of the western limit of these hills. Loti is a small, fortified village, which has only lately been built and occupied by Kechi Khan and his followers, who do not recognize the authority of the Bugti chief, but are on friendly terms with him at present. This settlement was formerly situated in the valley of the Pathr about 20 miles north, but was so harassed then by the Marris that it moved to a place further south, called Thusso, where a fortified village was built, but it was compelled to move again further south owing to the confined nature of the situation which did not allow of a sufficient space of ground being cultivated for its purposes. Kahan, the third place, is the capital of the Marri tribe, and lies about 24 miles north-west of Bugti Dera: two roads connect it with that place, one by the Shartaf pass to the west, and the other by the Barboj pass, which is 12 miles north-east. Of these, the latter is preferable as presenting less difficulties for laden animals, and with a little improvement would be quite practicable for wheeled conveyances all the way from Bugti Dera to Kahan. The Shartaf pass, on the other hand, is traversed with difficulty by laden camels, and it was at the summit of this pass that an engagement took place between the British and the Marris in 1850, whose our troops were first repulsed, but eventually carried the pass with some difficulty: the absence of any water at the top added to their hardships.

The most marked features of the country are, first, the Geandhari hill, which is the southern limit of the Suleman range, and from here gradually dies away into the Sind plain; the next, the Zin range, bounds the Sehaf valley on the south, and is only about 50 miles in length, commencing from the Dasht-i-Goran plain, in the middle of which Loti village is situated, proceeding due west and terminating the Kachi near Lohri. This portion of the country is particularly rich in fossil remains, every portion being covered with sea shells, and very slight excavations revealing the remains of sea animals, clearly indicating that the whole country was under water at a comparatively recent date. Some beds of fossils, situated near Bugti Dera, were examined by a geological surveyor, and pronounced by him to consist of the remains of rhinocerii and some species of elk. North of Bugti Dera another noticeable range, called Pir-ka-roh, runs parallel with Zin, and is very similar to it in contour, round and undulating on the north face, but precipitous and craggy on the south. The Siah Koh range bounds the Sham plain on the west and the Sulemans on the east. This plain is very rich in pasturage, has numerous perennial springs, and is visited annually during the dry weather by large numbers of the neighbouring tribes, who bring their flocks and herds here for grazing purposes. The chief route from Sind to Thal Chotiali, and thence to Quetta, traverses this plain, entering it on the east by the Chachar pass and going out at the north-west corner over the Vianck pass, which crosses a shoulder of the Siah Koh range at an elevation of about 2,000 feet: this pass presents no difficulty for laden animals, and water is abundant all along this route to Thal Chotiali. Vitakri, an abandoned cantonment of ours, lies immediately beyond this pass, close to the fertile valley of Barkham, which is thickly studded with small fortified villages and thals (towers), and is cultivated over its whole extent.

The chief of these villages is Nahar-ka-kot, where the sirdar (Khetrani) resides: from this plain on the west rises the high mountain range of Jondran to an elevation of 6,700 feet. It is very difficult of access from this side, but is more practicable on the west face from the Kolu valley. The Bugtis are chiefly a pastoral people now, cultivating only sufficient cereals for their own absolute wants, and those of the coarsest and hardest kind, such as jawar and bajra, with a little wheat, which require but little care or irrigation. The exports are chiefly sheep skin and wool, which are, however, imported again from India in the shape of poshtins and blankets.

Extract from the Narrative Report of LIEUTENANT-COLONEL C. T. HAIG, R.E., *Deputy Superintendent, 1st grade, in charge Guzerat Topographical Survey;—season* 1883-84.

DURING the past season about 455 square miles in sheet 41, rather more (about 34 square miles more) than half of sheet 42, half of sheet 43, and about three quarters of sheet 44 have been finally surveyed, completing the topography of sheet 41 and the 4-inch scale survey of the Godhra, Kálol, and Hálol talukas in that sheet and in 42 and 43, and adding about 200 square miles to the credit of our account with the Baroda State, leaving us with a surplus of over 250 square miles towards next year's account. Besides the topography, sheets 52, 53, 54 and 47 have been prepared for final survey by triangulation and traversing.

In sheet 43 is the hill of Páwágarh, which, with the remains of the old city of Chámpáner at its base, forms an object of considerable historical and archæological interest, as it abounds with old Jain temples, more recent Muhammadan fortifications, mosques, buildings and tanks, and still more recent Hindu temples. These have been abundantly described in various works, but judging from a correspondence I had with the late Sir E. C. Bayley, K.C.S.I., no map of the place had been previously made to enable the historian to give an adequate topographical description of it. The late Professor Dowson left behind him an unfinished history of Guzerat, which Sir E. C. Bayley undertook to edit, and he was very anxious to get a map of Páwágarh and Chámpáner for insertion into the work, but none was procurable, so he wrote to me about it, and I was

therefore careful to instruct Mr. S. Norman, to whom I allotted the survey of the hill, to be very particular in marking the sites of all old temples and ruins, and in attaching the correct names to all objects of historical and archæological interest, and to survey the hill and the old city with all the accuracy the scale admits. I visited both hill and city in the early part of the season, but was not able to go over it again and inspect Mr. Norman's survey, as it was not quite complete when I left; but this was done by Lieutenant-Colonel Badgley, and I have no doubt that all that can possibly be required for Professor Dowson's history will be found in the map. Unfortunately Sir E. C. Bayley has recently died, and I have not heard who is carrying on the editing of Professor Dowson's work.

Extract from the Narrative Report of MAJOR T. T. CARTER, R.E., *Deputy Superintendent, Survey of India, in charge No. 2 Party, Bhopal and Malwa Topographical Survey;—season* 1883-84.

Remarks on the country triangulated.

THE triangulation carried on this season in sheets 58 and 59 was chiefly in Dungarpur, with portions of Oodeypore and the Mahikanta Agency (Bombay Presidency). Both sheets are for the most part covered with thick jungle, are hilly, and the ground intricate; there are fair tracts almost all over where laden camels may be taken, and no difficulty was experienced in moving camp, except to the eastern limit of the work, near, and to the north of, the villages of Katharia and Valicha, where the ground is very much broken up by deep ravines.

The northern half of plane-table 58E is pretty open, but has some good-sized hills to the north near the junction with the Gwalior and Central India Survey; the southern half is more broken up with small hills, and is rather intricate north of the high road passing from Sagwara to Dungarpur. To the north and west of the Thanna village of Atri are the famous Pals of Hirathu and Mandu, which the detail surveyor must be careful in entering; some difficulty was experienced in poling the ground, and timely notice had to be given to the Dungarpur Durbar, which had to make special arrangements whenever these parts had to be entered.

Plane-table 58W has also some open bits to the north, but the hills are more massed than in the adjoining plane-table; there is a Pal called Padri at the foot of the low range running north and south near the boundary between Dungarpur and Oodeypore, which the plane-tabler must be careful in entering; the southern portion of this table is hilly and covered with jungle, and gets rather intricate to the south and south-west.

The upper half of plane-table 59W is about the most intricate piece in the whole of the work, being a mass of hills with small table-lands covered with thick jungle, and difficulty will be experienced by the plane-tablers in seeing points; the southern portion of this half breaks into low hills and undulating ground, also covered with jungle. With the exception of one range running north and south, the southern portion of this board is a low table-land covered with very thick jungle. Plane-table 59E is also a mass of hills, especially at the north-west corner; the southern portion has low hills and undulating ground covered with thick jungle.

Description of country plane-tabled. Sheet No. 50.

The whole of this sheet consists of hilly ground forming portions of the Native States of Oodeypore, Banswara, and Dungarpur; the river Som, which enters this sheet at the north-west corner, runs due east, half way through the sheet, when taking a bend it flows in a south-easterly direction to its junction with the Jaknam river, near the village of Bilodia: up to this point it forms the boundary between Oodeypore and Dungarpur; it then continues its course nearly due south up to its junction with the Mahi at Benisar, a well-known place where an annual fair is held. The country south and west of the Som consists of low hills intermixed with numerous small valleys, except to the north-west corner, where the hills rise to a height of 1,200 feet, the height of the banks of the Som river, at its juncture with the Mahi at Benisar being 550 feet above sea-level; in the ground rising to the west the slope is considerable, and the general level of the country seems to have been washed away, leaving innumerable small nodular hills, rising about 50 feet above the ground, forming a tangled mass of low hills covered with small pieces of quartz; they are quite bare, but so intricately massed together that much patience and care had to be exercised by the detail surveyor in sketching them. The valleys lying between these hillocks are, however, very fertile, and this portion of the sheet contains several large villages; the valleys are well studded with Moha, *bassia longifolia*, mangoe, *magnifera indica*, and sindi, *phœnix silvestris*, trees; numerous wells also exist, the water of which, together with that of the Som along its whole length, is utilized for irrigation purposes, being raised up to the level of the surrounding country by means of Persian wheels, called in these parts *Rahats*.

Turning to the eastern portion of this sheet, we have the Mahi river entering about five miles from the north-east corner and flowing in a south-westerly direction, which forms for about six miles the boundary between Banswara and Oodeypore, and for the remainder of its course through this sheet the boundary between Banswara and Dungarpur. A portion of Dungarpur (area of 65 square miles) lies between the Jaknam and the Mahi; if it was not for this, the Som up to its junction with the Mahi at Benisar, and thence the course of the Mahi eastwards, would have been the southern boundary of Oodeypore. The whole of the

country represented by this portion of the sheet is wild, while that north of the Mahi river and west of the range of hills forming the water-shed, is almost entirely inhabited by Bhils; but the portion falling within the extreme south-eastern corner of the sheet is very fertile and contains several large villages. The low ground on the left bank of the Som river is undulating, and the intricate nodular hillocks, distinctive of the country on the right bank, are here met with, the river apparently dividing the country into two different formations of rock; the hills on the left bank being composed of igneous rocks, such as granite, &c., and (at Lohargarh, Pansola and Khemera, there are considerable quantities of iron stone) the rocks on the right of the river being more of an aqueous description, silicious rocks as well as limestone formation being chiefly met with.

Sheet No. 52.

The western portion of this sheet consists of small nodular hills, if anything more intricate than those described in sheet 50; another peculiar feature of the country being the numerous tanks formed by the closing up of the water-courses by mud embankments: these tanks are constructed for irrigation purposes, and towards the end of April are for the most part dry. The Mahi river runs through the sheet from north to south, forming the boundary between Dungarpur and Banswara: about two-thirds of the sheet lies in the latter State. At the north-east corner the hills are more massed, rising to a height of about 1,000 feet above the sea; the eastern portion of the sheet surveyed the previous field season under Major Wilmer's supervision is more open, nearly the whole of it being covered with villages, and the land being brought well under cultivation with wheat, gram, sugarcane, &c. The main road between Banswara and Dungarpur passes through this sheet, and a few miles west of Talwara runs a range of hills, which rise to a height of 975 feet at their highest point, containing several Bhil Pals under the petty Thakurs of Amja and Talwara. The inhabitants of these Pals seem to be a marauding gang, and travellers should be on the look out for them; my post bag was twice robbed on this road, and I heard of one Pindari who was robbed of Rs. 600 in the same neighbourhood.

The natural features of the country being hilly and full of streams, it was by no means an easy sheet to survey, requiring great care and patience; fortunately, except on the more lofty hills mentioned, the features were bare.

Sheet No. 64.

This sheet is comprised almost entirely of Banswara territory, with the exception of a small portion of Dungarpur, in the north-west corner, and of Sunth (Rewakanta Agency, Bombay Presidency) in the south-west corner; the boundary of Kusalgarh, which forms a compact domain in the south of Banswara, and the boundary of Khándu, are shown to the east of the sheet. The chieftains of Kusalgarh and Khándu belong to the reigning family of Banswara, being descended from Pretvi Raj, the first Chief of Banswara. Kusalgarh contains 170 villages, and Khándu 40; the Rao of the former holds the position of a guaranteed feudatory to the Rawal of Banswara. The Khándu chief is a first class noble; the boundary of his domain was shown in sheet No. 53 already published, and has therefore been continued in this year's work; the greater portion of Kusalgarh will enter into the work of the Guzerat party.

A large portion of Banswara entering into this sheet belongs to the Rao of Garhi, the second largest first class noble in the State; he owns 126 villages in Banswara, the majority of them being situated in the tract of country south of the Anás, and between that river and the Sunth State. The whole of this country at one time belonged to Sunth, and was known as the Chilkari district, being together with Kusalgarh and Khándu, almost entirely inhabited by Bhils.

The Garhi territory, however, is not sufficiently compact to admit of its being shown separately. The whole of this sheet, west of the Anás, and its tributary the Haran, is of the roughest description, comprising one mass of hills clothed with dense forest; the surveyor's difficulties were therefore considerable, and their progress slow. East of the Anás, except for about three or four miles from the river bank, the country opens out, and one of the most fertile tracts in Banswara is here met with, extending from about three miles south-west of Banswara City to Kusalgarh, and containing several flourishing villages, the inhabitants of which are all cultivators; the land produces very fine crops of Indian corn, rice, wheat and gram. Although nearly the whole of this sheet is inhabited by Bhils, they appear to be well controlled by the Raos of Garhi, Kusalgarh and Khandu, and in consequence of the judicious management of the surveyors employed, no difficulties arose.

Forts.

There are no forts in this year's work, but at Chandarwara and Shergarh, two thana stations of Garhi, as also at Bhopatpura, a thana of Banswarh, and Partabgarh, thana of Sunth, there are walled enclosures about 40 yards square with towers at their four corners; the walls being about 15 feet high; at Bhopatpura the walls are of mud, but at other places of brick; within the enclosures their block houses are evidently built as places of refuge, for protection in case of any sudden rising of the Bhils.

Towns and cities.

There are no large towns in this year's work, but the following are the principal villages which enter into each sheet:—

Sheet No. 60.

Parsola, $\frac{\text{Lat. } 23^\circ\ 57'\ 0''}{\text{Long. } 74^\circ\ 26'\ 36''}$ population 840, in Oodeypore, a thana station on account of its iron mines, of which there are several, and from which a peculiar description of iron-ore can be obtained, but the manufacture of iron has fallen off considerably of late. At the time of my visiting the place there were only three wind furnaces at work.

Ghatol, Lat. 23° 45′ 20″, Long. 74° 27′ 12″, population 1,138, one of the largest villages in Banswara on the road to Danawad in Oodeypore.

Jagpura, Lat. 23° 51′ 56″, Long. 74° 23′ 24″, population 400 and Doogaria, Lat. 23° 51′ 57″, Long. 74° 30′ 9″, population 264. These are here mentioned as they are thana stations situated among the Bhil villages in the northern portion of Banswara.

Motagaon, Lat. 23° 49′ 18″, Long. 74° 17′ 40″, population 1,014 and Gamri, Lat. 23° 45′ 2″, Long. 74° 20′ 15″, population 588, are the residences of two of the Choban Thakurs of the first rank; the former holding 7 and the latter 11 villages in the neighbourhood; but like most of the villages the residences of these Banswara nobles are chiefly conspicuous for their having been thoroughly neglected and allowed to fall into ruins.

Bankora, Lat. 23° 49′ 16″, Long. 74° 2′ 35″, population 2,060; 27¾ villages; Salaj, Lat. 23° 54′ 27″, Long. 74° 21′ 35″, population 1,500, 14 villages; Sabla, Lat. 23° 57′ 43″, Long. 74° 13′ 5″, population 1,388, 3½ villages; Nandli, Lat. 23° 55′ 55″, Long. 74° 9′ 49″, population 412, 5½ villages; the residences of four of the first class nobles of Dungarpur.

Aspur, the thana station of the eastern portion of Dungarpur, Lat. 23° 57′ 18″, Long. 74° 7′ 8″, population 1,022.

Loaria, Lat. 23° 45′ 35″, Long. 74° 15′ 44″, population 1,024, at one time a place of considerable importance on account of its iron mines; the iron-ore being obtained from four small hills to the south-west of the village, but the mines are now abandoned.

Banswara, Lat. 23° 32′ 43″, Long. 74° 29′ 23″, population 6,000, the capital of the State; a walled city, but the walls in many places have fallen into disrepair; several of the tradesmen's houses are built of stone; the palace stands on rising ground to the south of the city, and is surrounded by loop-holed walls. The kutchery and public offices, which are small, are in a walled enclosure on the level ground to the west of the city, which also contains one of the residences of the Rawal; on the level ground between the city and the kutchery a fair is held annually in November, the booths are entirely composed of the stock of the shops of the town, which are closed during the fair by order of the Durbar. Cloth, pots and pans, bangles and other cheap ornaments seem to be the chief articles for sale; the fair is well organized, and is orderly and clean; detachments of sepoys from the regiments of the first class Thakurs assist in keeping order; the purchasers seem to be entirely Bhils, who flock to the fair in great numbers.

Sheet No. 52.

The villages as per margin, the residences of first and second class Thakurs, belonging to Banswara, enter into this sheet. The Rao of Garhi has established a school which keeps open for six months in the year, and attempted last year to open a dispensary, but the Hospital Assistant declined to remain after a few days, as the place was very unhealthy.

Garhi, Lat. 23° 35′ 21″, Long. 74° 11′ 24″, population 1,582, 126 villages, with a school during the winter months.

Motwala, Lat. 23° 43′ 19″, Long. 74° 12′ 35″, population 181.

Arthuna, Lat. 23° 29′ 50″, Long. 74° 8′ 15″, population 1,450.

Talwara, Lat. 23° 33′ 52″, Long. 74° 21′ 56″, population 1,573.

Amja, Bhimsur, Bilowasa, Orwara and Umara, the residences of second class Thakurs.

Partabgarh, a large Brahmin village, Lat. 23° 35′ 28″, Long. 74° 13′ 11″, population 1,686, on the road from Banswara to Dungarpur, and the thana station of Tezpur, also enter this sheet. Crossing the Mahi into Dungarpur territory, we have Galia Kot, Lat. 23° 31′ 7″, Long. 74° 1′ 30″, population 1,950; at one time the capital of Dungarpur, before that State was divided into two, about the fifteenth century, where are the matas or monuments erected to the memory of the ancestors of the present Maharawal of Dungarpur; there is also a Mussulman shrine, which is a place of pilgrimage, much frequented by the Boras of Guzerat; a large fair is held at Galia Kot at the end of March. It is the head-quarters of one of the thanas of Dungarpur.

Sagwara, Lat. 23° 40′ 32″, Long. 74° 3′ 55″, population 4,860; at one time a place of considerable importance; in 1857 there was a general flight of the population to Partabgarh, and it is now in a state of disrepair; the Maharawal usually spends some weeks here on his way to and from the Benisar fair, in February; there is a Government post office and school.

Chitri, Lat. 23° 33′ 23″, Long. 74° 1′ 21″, population 803, the residence of one of the first class nobles of Dungarpur enters sheet 52; he owns 7 villages.

The principal places in this sheet are, Tanbesra, Lat. 23° 18′ 42″, Long. 74° 23′ 25″, population 430, the principal village of the largest Rajput Thakur in Kusalgarh; there is a weekly market held here, besides a fair on the 15th of each month. There are 20 villages belonging to Tanbesra, Kalinjra and Bhopatpura, thana stations of Banswara.

Sheet No. 54.

Chinch, Lat. 23° 32′ 55″, Long. 74° 21′ 11″, population 1,650; Wagidora, Lat. 23° 24′ 31″, Long. 74° 18′ 26″, population 1,129, and Nogama, Lat. 23° 26′ 53″, Long. 74° 18′ 5″, population 1,145, are three large villages situated in the fertile tract of country south-west of Banswara.

Talwara Ghat, a pass on the main road from Banswara to Dungarpur, about four miles long; it has always been infested with robbers; the lands about Talwara were given to the Thakur Gopinathji, and he was raised to a first class Thakur to keep the pass open; it is still unsafe for travellers, but is easy to traverse.

Hills and passes, sheet No. 52.

Sheet No. 54.

The Dhani Chaotra Ghât on the road from Sunth-Rampur to Galiakot, an easy pass, but surrounded with densely-wooded hills. The Khargor Ghât leading from Shergarh to Bhukia is easy to traverse, even with carts.

Hills.

The only hills were the Kharjhu range in sheet 54, terminating on the western extremity in the Mangarh hill, a bluff scarped hill, overlooking the thana of Partabgarh at the junction of the Sunth and Banswara boundaries; this hill bears traces of having been once fortified; it is ascended by an easy bridle path from the south, but is inaccessible from any other direction.

Roads.

The only roads deserving the name are, the main road from Banswara to Dungarpur in sheet 52, passable for carts, but unmetalled and unbridged, and the road from Banswara to Kalinjra, at which point three roads branch off, one to Kusalgarh *viâ* Tambesra, the second to Jalod *viâ* Bhopatpura, and the third to Sunth-Rampur *viâ* Shergarh and Fatehpur, none of which are metalled, but are feasible for wheel traffic; the former crosses the river Haran at Kalinjra, and the two latter cross the Mahi river; as these rivers are not bridged, the roads are impracticable during the rains. There is also a fair road from Sunth-Rampur to Partabgarh, thana Kherapa, and thence carts can be taken on to Galiakot and Sagwara, on the main road from Banswara to Dungarpur. There is very little wheel traffic, pack bullocks and donkeys being chiefly used. Camel carriage was entirely used by the Survey Party, and there was no difficulty in moving about any part of the country.

Rivers.

The Mahi, with its tributaries the Jaknam, Chap, and Som; and the Anás, with its tributary the Haran, are the only large rivers which enter into this year's work. They are all unnavigable.

The Mahi.

The Mahi enters sheet 50 at the north-east corner, takes a south-westerly course, and about half-way through the sheet is joined by the Som river at Benisar; sweeping south, it runs through the centre of sheet 52, and passes out of this year's work at the north-west corner of sheet 54; its banks are for the most part very precipitous, rising to 40 and 50 feet above the river-bed, and are also well wooded; the bed is as a rule very rocky, and the banks so steep that it is with difficulty crossed, except at the well-known fords; nine of which crossings, practicable for camels, are shown on the maps; two of these allow of carts passing over, but all may be made passable for carts without much difficulty.

The Anás.

The Anás which enters sheet 54 midway from the south, and takes a northerly course, is met by the Haran about half-way up this sheet; continuing its course to the north it sweeps round to the west, and passing along the upper edge of sheet 54, joins the Mahi at Bhetran; the banks of the Anás are, like those of the Mahi, wooded and very steep; the bed is equally rocky, and the river can only be crossed at well-known spots, four of which are shown on the map.

The Som.

The Som river enters sheet 50 at the north-west corner, and, flowing in an easterly direction, traverses about half the sheet, when it bends sharp to the south and joins the Mahi at Benisar; unlike the Mahi and Anás its banks are for the most part low, and may be crossed at most places without difficulty, except in the rains.

The Jaknam.

The Jaknam enters sheet 50, and flows through a rocky and jungly country, but is crossed with difficulty, except at the usual crossing.

The Haran.

The Haran, which enters sheet 54, is a small stream fordable anywhere without difficulty. With the exception of the Mahi and Som, the rivers mentioned are not perennial, but in the monsoon they become unfordable torrents.

Inhabitants.

In Banswara and Dungarpur the Bhils form the most numerous section of the population; the same may be said of the small portion of Oodeypore and Sunth, entering into this year's work in sheets 50 and 54; the country was originally conquered from them. All Bhils go about armed with bows and arrows; the head-men carry swords; they are very warlike, and their most serious affrays arise from cattle-lifting. The men wear long hair, the women are small and ugly, those of rank being distinguished by the number of brass rings on their legs, often extending from the ankle to the knee.

As a rule they were peaceably inclined, and with the exception of one case where a Klassie was severely wounded, and another where a Bhil in Danawad, (Oodeypur) was just stopped by Sub-Surveyor Sheik Oomer, at the very moment of drawing an arrow at one of his klassies, the surveyors were not molested; but then they were always accompanied by a vakil and guard from the durbars, and by one of the latter while out at work. The post was robbed on two occasions; the dominant class are Rajputs; the Chiefs of the first class are called tazimdars; they are for the most part connected by marriage with the Rulers of Banswara and Dungapur, who themselves claim descent from an elder branch of the family which now rules at Oodeypur.

Products, soil, &c.

The following crops are grown in the winter and spring: wheat, barley, gram and sugar-cane; opium is grown to a small extent only in Banswara, but in considerable quantities in the Dungarpur State. In the rainy season, Indian corn, til, arad and several kinds of rice are grown; kudra or kodo, a coarse kind of small grain of the rice species, is what is chiefly sown on the hills, and wherever

the soil is poor, and is what the Bhil chiefly lives on. As a rule, the soil in all the villages is very good, being either black or a rich red loam: the lower hills are very bare of soil, but every small valley is dammed up, the natural drainage is stopped, and there is a silting up in all their villages of surface scourings from the hills, and the crops met with are generally very good.

Extract from the Narrative Report of MAJOR J. R. WILMER, *Deputy Superintendent, Survey of India, in charge No. 5 Party, Mirzapur Topographical Survey;—season* 1883-84.

Country triangulated.

THE country triangulated extended over a portion of the Kaimur range, north and south of the Son river; it presented a few difficulties, and some of the sides of the triangles were very small. There was a good deal of jungle to be cleared before rays could be obtained.

Country surveyed in detail.

The country surveyed in detail was very much the same as that met with in the previous season, that is hilly, and with many ravines near the rivers, and more or less covered with jungle; sometimes very densely so. This makes the survey of it very laborious and slow. It is also very unhealthy until the cold season has well set in. The mornings are foggy until about 8 or 9; sometimes so much so as to render surveying impossible until the mist has dispersed. Heavy dew also falls at night, making the tents as wet as if they had been rained upon. The manners and customs of the inhabitants are fully described in Mr. Connybear's report of the Mirzapur district, as is also the nature of the soil, produce, &c. No large rivers were surveyed this season, and no large important ranges of hills.

Extract from the Narrative Report of MAJOR J. R. MCCULLAGH, R.E., *Deputy Superintendent, Survey of India, in charge No. 8 Party, Mysore Topographical Survey;—season* 1883-84.

Plan of operations.

THE plan of operations included triangulation in degree sheets IX and XIII, also for the large scale survey of the Mysore city, a certain amount of theodolite traversing in degree sheet XIV, the detail survey of standard sheets Nos. 3, 51, 52, 53, 59, 60, 61, 64, and 65, and lastly the detail survey of the city of Mysore on the scale of 12″=1 mile.

Remarks on the country finally surveyed.

The country topographically surveyed this year exhibits the varied and diversified features usually met with throughout the province of Mysore. From the mountainous and thickly covered forest tracts found in the eastern parts of sheets Nos. 61 and 64, and western part of No. 53, to the hilly but bare landscape as seen in sheets 59 and 60, rolling down irregularly to the open but undulating plains dotted here and there by isolated mounds and hills, and now and again by scrub jungle in patches of no inconsiderable magnitude and density as met with in the eastern parts of Nos. 51, 52, and 53. The Cauvery river throughout no small extent of its course, several of its tributaries, notably the Homavati, Lakshmantirtha, Shamsha, and Arkavati; the falls of the Cauvery at Shivasamudra, of wide known fame, and the great attraction for travellers; another grand fall lower down the course of the river; also the fine falls of the Shamsha and Arkavati rivers, as yet hardly known of, unless perhaps to a few adventurous spirits and sportsmen, all lie within the field of operations and have come under survey this season.

General remarks.

The outturn of the season, though some 700 square miles less than the previous year, cannot, I trust, help being considered other than very good, and it is entirely due to the exertions of the party at large. All ranks, European and native, I think, deserve credit for having worked with a will to secure the results obtained, and what is of equal importance is, that the work has stood the test of a rigorous and searching examination. The 16 sections of the one-inch survey have, with one exception (that of Mr. James), been checked by test lines aggregating 569 miles, as well as by fixings *in situ*. In addition to observations with the clinometer by each of the detail surveyors, a very large number of additional determinations of height were obtained with the theodolite. These heights have materially helped to secure the accurate representation of the configuration of the ground. The eleven sections of the Mysore city survey underwent a searching investigation at my hands, and I have every confidence in their correctness. In this work the contours which represent 20 feet vertical interval have been laid down with great care by means of miniature water-levels, and though perhaps hardly up to the standard of work executed with a spirit-level, they have every pretention to considerable accuracy. The same system of contouring is being adopted in connection with the survey of the Bangalore town and cantonment.

Extract from the Narrative Report of MAJOR R. BEAVAN, *Deputy Superintendent, Survey of India, in charge No. 1 Party, Central India and Rajputana Topographical Survey;—season* 1883-84.

Remarks on the country triangulated.

THE country west of the Luni river has little to recommend it. Near Barmer there are some large hills which stand up abruptly from the surrounding country, but the rest of the tract is very flat and sandy; water is scarce, and what little there is, is generally brackish, except that which the villagers store in underground reservoirs or "tankas." This being rain-water, is sweet; it is not, however, used for ordinary purposes, but is kept as a reserve in case of drought in the summer. There is a good deal of cultivation when the rainfall is sufficient, and vast numbers of cattle are to be seen grazing about the country, which is by no means a desert, although the soil is sandy, and if the rainfall was only more abundant, it would be green and fertile.

Remarks on the country plane-tabled.

Standard sheets Nos. 100 and 103 lie principally in the State of Sirohee, and include the well-known sanitarium of Mount Abu. The Rajputana State Railway runs through these two sheets, in consequence of which labour is very high, and it is difficult to get coolies, even for a day's work for clearing jungle or cutting rays. The country is densely wooded, and, excepting the cultivated portions, is covered with thick thorny jungle and spear grass, which is most troublesome to get through; the hills also are very rugged and difficult to climb. There is a good deal of cultivation, however, in the more open valleys, and especially west of Mount Abu. East of the railway line is almost all jungle, the inhabitants of which are chiefly Bhils and Meenas.

Extract from the Narrative Report of H. HORSF, ESQ., *Deputy Superintendent, Survey of India, in charge No. 7 Party, Burma Topographical Survey;—season* 1883-84.

Remarks on the country triangulated.

THE country triangulated lies between latitude $\frac{18^\circ\ 0'}{18^\circ\ 45'}$ and longitude $\frac{95^\circ\ 45'}{96^\circ\ 0'}$ and comprises all the reserved forests in the Tharrawaddy district not previously triangulated. The nature of the country is the same as that described heretofore; the work extended along the western slopes of the Pegu Yoma range, which is not very marked, north of latitude 18° 20′ averaging about 1,300 feet above sea-level; but to the south it rises to 2,700 feet at Sanamongtong (elephant-trunk hill), latitude 18° 23′ 5″ longitude 95° 57′ 39″ and 2,650 feet at Kyauklada peak, three miles further. From this peak the range has an average elevation of 2,000 feet until Sanwinguntong is reached, where it rises to 2,260 feet.

The area plane-tabled embraces parts of the Thonze and Konbilin reserves, which are now entirely surveyed, the Kadin Bilin and Mokka reserves which are also completed, and part of the Minhla reserves. The eastern boundary of all the reserves, the Konbilin excepted, is in the Pegu Yoma, which attains a considerable altitude, and rises abruptly like a wall from the low hills to the east, showing a comparative height in the Thonze reserve of more than 2,000 feet in about a mile from the base of the range. Further north there is a series of high ridges running parallel to the Yoma, and in some cases overlooking it: there is a sudden fall then to the west, and the hills become low and intricate. The hill ranges vary from 1,300 to 2,600 feet in height above sea-level.

There are several large streams, impassable during wet weather when they become impetuous torrents, serving admirably the purpose of floating down timber which is collected in the dry season in the dry beds of the chaungs and their feeders, which are generally called Myoungs. The following are the chief: the Thonze chaung, which traverses the Thonze reserve from north to south; the Yetho or Kadin Bilin chaung, flowing through the Khadin Bilin reserve; the Mokka chaung, which passes through the Mokka reserve; and the Minhla chaung through the Minhla reserve, all which take their rise on the Yoma. The country is difficult to travel over, as there are only two or three main pathways practicable to elephants, and it is covered with dense primeval forest. There are a few Tés or Karen habitations, the principal of which are Thanga-za té and Payow té, both of which have been removed to other sites from the localities they occupied when the survey was made; and Chaungwa té and Yetho in the Kadin Bilin. In the vicinity of the latter there are permanent paddy fields; Panlete and Ombwate in the Mokka reserve, the site of the former having also altered since the survey. All are temporary habitations, liable to be shifted every two or three years for sanitary purposes, the Karens being filthy in the extreme, and to be known by other names after the death of the present headman or Sankes, from whom they derive their names. Notwithstanding the hardships to be encountered, life in the forest is not unbearable. The monotony is trying at first, but one becomes accustomed to that, and after a time prefers working there to the bare, hot, and dazzling plains, where there is nothing to relieve the eye. The Bhoosa Klassies, who come from the Hazaribagh district, are perfectly miserable out of the forest, and in consequence prefer this to the cadastral parties. With proper precautions one enjoys fair health, still there is always a gnawing feeling of uneasiness, as the attacks of illness are sudden and frequently fatal. Any further description would be only a repetition of what was reported last year.

Pathways and passes.

(*a*) There is a well beaten and cleared path from Way *vid* Kodugwe (a deserted village site), Chaungyua, Yetho, and Panlay to Seyna, which is situated on the Minhla

chaung in latitude 18° 6′ 12″and longitude 95° 56′ 2″, on the western edge of the reserve of that name. It is practicable to lightly-laden elephants, though some parts require widening out every year.

(*b*) Another from Letpadan and Minhla on the Rangoon and Prome Railway line *viâ* Khwe Makain along the Bilin chaung to Yetho through the Kyauktaga pass in latitude 17° 59′ 50″and longitude 96° 2′ 10″, about two miles west of the Yoma, crosses the ridge in latitude 17° 59′ 5″ and longitude 96° 3′ 45″ and leads to Shwe-we-te and Sagalay-te. There is a Burman encamping ground on the Yoma, where perennial springs exist, affording a plentiful supply of water. This path is practicable to lightly-laden elephants after leaving Yetho, excepting a few chains over the Kyauktaga pass, which can, without trouble, be rendered easy by blasting a few rocks. Kyauktaga signifies literally rocky door or opening. from *Kyauk* a rock, and *taga* a door or opening.

(*c*) A third, practicable to elephants from Yetho along the Taung chaung and Kyauklongyi chaung crosses the Yoma in latitude 17° 57′ 7″ and longitude 96° 4′ 36″, about four miles north of Sanwinguntong hill to Sagalay-te.

(*d*) A fourth, impracticable to elephants, from Yetho along the Yetho and Takaupi chaungs, crossing the Yoma in latitude 18° 2′ 35″ and longitude 96° 2′ 23″, and leading to Shew-we-te and Lati-te.

When the survey of the country to the east of the Yoma is taken up, it will be necessary to utilize *b*, *c*, and possibly *d* for the conveyance of provisions from the Rangoon and Prome Railway, a distance of 50 miles or more, as supplies are not procurable on the eastern slopes except from much longer distances, and it will then be necessary to have at least 15 elephants attached to the party, as local carriage is nowhere procurable.

Scarcity of water.

The scarcity of water during the last six weeks of the field season was seriously felt, and time was lost in searching for springs or digging wells, frequently without success. Pools were often met with, but generally poisoned by Burmans for the purpose of killing fish. This is a punishable offence, but the delinquents take good care they are not detected, as they usually carry on such practices by moonlight.

Mr. Wilson introduced a system of working by sound instead of flags, which facilitated matters considerably, and the result was most satisfactory. The method adopted was to send a klassie about 15 or 20 chains in the proper direction, and on his taking up a position, he struck together, at short intervals, two dry and hollow bamboos, one considerably thicker than the other, which produced a sharp sound, and if there was no higher ground intervening, which of course had to be guarded against, the ray taken in the direction whence the sound proceeded was seldom out by more than 15 or 20 links, which on the 4-inch scale is not appreciable. After a little practice the ear becomes so perfect that even the chainmen moved along without diverging, and very little clearing was necessary. The system might with advantage be still further utilized by sending men to bends of streams and cutting in from two or more fixings on the ridges. The experiment will be tried, and if it does not give satisfaction for the insertion of features to be rigorously surveyed, it will doubtless prove useful for approximate work.

Notes on the manners and customs of the Karens by Mr. J. H. Wilson, *Assistant Surveyor, 1st grade.*

The marriage ceremony of the Karens is an extremely simple and primitive form, although just as binding as others more elaborate. The hill Karens never intermarry with Burmans: their simple modes of life would ill-harmonize with those of the Burman, who is viewed by the Karen as possessing the punctilious notions of the "Cityman." The invitations to a marriage ceremony are always issued during a previous similar occasion when all are assembled, thus avoiding the expense and inconvenience attendant on sending messengers about. The bridegroom proceeds to the house of his fiancée in the ordinary eastern fashion, heralded with music and a motley throng of revellers, who enter into the spirit of the gaieties most heartily, frequently imbibing copious draughts of their home-brewed whisky as if to whet their lagging spirits, yet, although most of the guests are fairly under the influence of liquor, added to the excitement and jostling of the crowd, anything like a brawl or wrangle among them is unknown. The characteristic feature of this procession, when compared with those organized in India, where the bridegroom is lionized and impromptu ballads composed in his praise, is most singular, as it consists of the bridegroom forming the most insignificant individual in the crowd, where one and all are arrayed in gala attire and this seemingly miserable wretch is conspicuous in his ordinary apparel and by occupying the last place in the procession.

When the house of the bride is reached, the guests ascend the bamboo ladder leading to the guest chamber; on reaching the last rung of which, each man is helped to a cup of whisky before entering the hut, but the bridegroom, who as usual comes last, is utterly denuded of his clothing and favoured by a shower bath from one of the elderly dames, which he receives with the air of a martyr, together with the liberal allowance of whisky. But now the scene changes, and the bridegroom on adorning himself with suitable garments seems already to enter upon a new episode in his little history by assuming the more dignified position of host and benedict combined.

Meanwhile the company inside the building range themselves in two sets, men and women apart, to partake of the feast provided, after which liquor is again requisitioned in order to induce the bashful youths to express their sentiments with reference to the maidens of their choice, which is conducted in the following manner. One of the young men addresses the lady of his selection with three puzzles, which, if replied to with sufficient adroitness, is generally equivalent to a consent to his implied proposal of marriage. But if the challenge to solve the riddle is not accepted, the failure is considered tantamount to a rejection of the suitor. The puzzles invariably consist of an absurdity, and are considered as solved when met by equally ingenious ones. After the interchange of three such questions satisfactorily, the day and hour for the wedding of the parties is appointed, and invitations verbally uttered, thereby forcibly illustrating the advantages of the system of short engagements over more civilized forms of protracted ones, resulting frequently in breach of promise suits.

Notes on the forest reserves by MR. C. P. TORRENS, *Assistant Surveyor, 1st grade.*

THE Minhla forest covers an area of about 60 square miles, and is drained by the Minhla chaung. A long narrow strip of ground running north and south along the length of the forest is given over to the Karens, and contains the following "tes"—Gna-sa-te, Pono-te, Tekwa-te and Poshwezin-te.

The Gamôn forest comprises an area of about 80 square miles; the southern portion is drained by the Gamôn chaung, and the northern by the Taung chaung. This forest has a large patch of ground, which has been given over to the Karens, who inhabit the following tes—Pinding-te and Phomonsi-te.

The Bawbin forest has a larger area than either of the above two, and covers about 110 square miles. The Bawbin chaung, with its tributary the Kyaukpyu chaung, drains this tract. The Karens have two grants in this forest, the northern and larger one contains two tes, Tha-dwe-te and Ko Pan-ai-te, the southern and smaller one has Tone-San-te.

The Minbu forest is very small and contains only 20 square miles; it is drained by the Minbu chaung. The forest is uninhabited, and does not even contain a single Karen te.

The Taungnyo forest covers a very large area, and is drained by the Taungnyo chaung with its tributaries the Nyan-te, Sinzew, Pa-nyo-gale, Mwe-gyi, and Pa-nyogyi chaungs. It is divided into a number of small reserves, of which the following came under survey this year:—Taungnyo, Nyanle, Pazinje and Kani.

The hill of Taungnyo-Myo in the Taungnyo forest has a history attached to it, but beyond the fact of its having been used in days bygone as a Burmese sanitarium, I could gather nothing further regarding it.

Sabataung, a well-known hill in the Taungnyo forest, has also its history. Tradition says that it was here the princess Sabu (after whom the hill is named) took up her abode and hid herself from the king of Ton-ta-long, who was in love with her and persecuted her. It is believed that her jewels and other valuables are yet hid in some part of the hill.

The Taungnyo chaung is a large and important stream; the manufacture of cutch is carried on to a very large extent on its banks. Cutch is chiefly made by men from Upper Burma, who come down in large numbers in December, and take up their residence along the streams. The making of cutch is very laborious, the tree has to be felled and brought up to the place of manufacture; it is then cut up by hatchets into small chips of about $2'' \times 2'' \times \frac{1}{2}''$. These chips are then boiled for about a day in earthen pots, when the cutch is extracted. The cutting up of the wood is done by the men, and the boiling by women. The cutch in an unclarified state is sent to Paungde, where it is subjected to a second process of clarification before being exported. Although cutch making is very tedious, it appears to be remunerative, as from what I could learn a hard working man earns Rs. 25 a month and thus clears Rs. 125 during the season. The work closes about May, when the rains set in, and the men return to Upper Burma.

Notes by MR. R. A. GIBSON, *Assistant Surveyor, 1st grade.*

THE Hle-don Kyan is a low range of hills, which forms part of the boundary between the Kadin Bilin forest reserve and the Etho Karin area. The range is named after a boat which is to be seen on it; the following information regarding which was gathered from a Karen resident of Yetho.

Over fifty years ago, long before the British took possession of the land, there lived a Burman Chief. Desirous of getting into favour with the king, he thought of performing a wonderful feat, and thus gain his ends. For this purpose he had a boat constructed on this hill, out of an immense teak tree, and intended it for a royal pleasure boat. After consulting the astrologers, a day was fixed for launching the boat on a stream which flows some 300 feet below. Grand festivities were held on the occasion, but notwithstanding the number of buffaloes and men employed to drag the vessel, it could not be moved beyond a few feet. All who were engaged in the work of moving the boat died, as the nats (spirits) did not wish the scheme carried out. As the Burmese are very superstitious, the boat was left on the hill, and there it stands to this day, where it can be seen, slightly damaged at one end by jungle fire. Overcome with mortification at his failure, the Burman Chief died.

On the Pegu Yoma range, within the ground allotted to me for survey, there is a beautiful spring, situated about 1,500 feet above sea-level, in latitude 17° 51′ 15″ and longitude 96° 6′ 26″. It is called the Kunyoni Yesan after a betel-leaf plant which grows near it (*Kunyone*, signifying red stalk betel-leaf and *Yesan*, spring). This plant is held in great reverence by the Burmese and Karens of the neighbouring country, and is believed by them to have been planted centuries ago by a good nat (spirit), who is supposed to look after it still. They say the plant will never wither, and that it is a fact that the elephants, rhinoceri and other wild animals which frequent the spring for water have never destroyed it. The Burmese will often travel miles to secure a few leaves of this plant for medicinal purposes; it is also believed to possess a charm for lovers, and a man firmly believes that if his fiancée would eat a single leaf obtained and given by him, it would increase her affections for him. The plant is about two inches in diameter, and creeps up to the height of about 100 feet over the trees surrounding it, covering the whole of them with its leaves. Bamboo ladders are attached to these trees in order to obtain the leaves, which are procured from a height of 30 to 50 feet.

Extract from the Narrative Report of MR. A. M. LAWSON, *Surveyor, 2nd grade, Officiating in charge No.* 10 *Revenue Party, Konkan Survey;—season* 1883-84.

Limits of work.

The work of this season lay in the most inaccessible part of the Thána district. The Western Ghats and the sea bounded the work on the east and west; the parallels 20° and 19° 45′ forming the northern and southern limits.

Description of country.

The country surveyed, includes the Mokáda sub-division of the Sháhápur Táluka, the Jawhár State, and a portion of Dáhánu Táluka.

Near the centre of the eastern margin of the work is Bajgad, 3,575 feet, and about a mile to the north the lofty peak of Votur, 4,081 feet. From Votur a spur running north and west forms the Assa table land and the watershed of the Vág and Vál rivers. North and south of Votur peak the Ghats have an altitude of from 2,000 to 2,300 feet; dipping abruptly towards the west to about 1,500 feet, there is a belt of rolling grassy uplands, some six miles wide, seamed by steep rocky ravines. The country again rises to an altitude of 1,700 feet, forming the Suriamal and Kevanála plateaux south of the Pinjal river, and the Jawhár, Kasetwari, and Kokda plateaux on the north. Ten miles further west the country becomes broken up into various forest-clad hill-ranges, until some six miles from the sea there is a stretch of flat country, fringed with palm trees along the coast, and intersected by tidal creeks and broad salt marshes overgrown with mangrove bushes.

The principal hills not already enumerated are Bhopatgad (1,608 feet), south of Jawhár, the hill fort of Asheri (1,689 feet), and the curious funnel shaped hill Máhálaxmi or St. Valentine's Peak, 1,526 feet.

Rivers.

The watershed of the country being limited by the Western Ghats, none of the rivers drain a large enough area to become of much importance; the largest are the Pinjal, the Vág and the Vál, all of which rise in the Votur hill. The next in importance are the Deherja and the Surya, both of which have their source on the Jawhár plateau. With the ordinary rainfall, all these rivers have a good flow of water up to the end of February; and as their course is mostly between high hills covered with dense forest, the water power now wasted might be utilized in cutting up the timber, which at present is conveyed coastwards with great difficulty, and at much expense.

Roads.

The country surveyed is almost destitute of roads. The eastern portion entirely so. The paths in some parts are nearly impassable owing to the deep rocky banks of the streams to be crossed. There is considerable traffic on pack animals from Jawhár eastwards by way of the Ghond Ghat to Nasik, and by the Dondmari and Shir Ghats to Igatpuri. The westerly route, from Jawhár to Dáhánu, has a well-made road, descending from the high table-lands, by the Kasetwari and Deng passes. The latter portion of the road from Sava to Dáhánu is in course of construction. There are also a few cart tracks leading from the coast along the valleys of the larger rivers, used during the fair season for the conveyance of wood to the coast and the stations of the Bombay, Baroda and Central India Railway.

Railway.

The Bombay Baroda and Central India Railway runs through the western margin of sheet 81, the following railway stations falling within the limits of the work,—Boisur, Vangaon and Dáhánu Road.

Towns.

There are many hamlets scattered over the country, but no towns or villages of much importance, except along the coast. The largest, Tárápur, on the south bank of the creek of that name, and Chinchni, on the north bank (known by the joint name of Tárápur-Chinchni), has a population of 7,000, and a small export and import trade. Dáhánu, the head-quarters of the taluka of that name, has a population of 3,500. Six miles to the east, on the Dáhánu creek, is Savta *bandar* (landing place) where large quantities of timber are yearly shipped from the Jawhár State. Mokada lies in the hilly country under the Ghats; it is the head-quarters of the sub-division of that name, but otherwise of very little importance. Jawhár, the capital of the Jawhár

State, and the residence of the Raja, is on a table land which runs north and south between two deep gorges. A few years ago Jawhár—with the exception of the Raja's residence—consisted of only a few thatched huts. The Raja, however, has made it a place of some importance by giving free grants of timber for building to induce traders and others to settle there. There are now some well-built dwellings, and the Raja (who administers his own state) has built public offices, a school-house and dispensary, and improved the water-supply. Jawhár is cool and healthy, except just after the rains; the plateau is covered with fine mangoe trees, and its elevation (1,519) and proximity to the sea makes it a most desirable place for camping during the hot season.

Extract from the Narrative Report of MAJOR J. E. SANDEMAN, R.C., *Deputy Superintendent, Survey of India, in charge No. 5 Party, Mirzapur Revenue Survey;—season* 1883-84.

Nature of establishment.

THE establishment of *amins* was a very poor one and the proportion of first class men was very small. The increased grant to enable 800 square miles to be accomplished necessitated the employment of over 200 *amins*. Out of this number only 127, of whom 37 could not read or write Urdu, had been employed the previous season. These 37 men were too ignorant to be entrusted with the records, and for them *muharirs* had to be engaged.

European inspection.

Each camp had one European assistant in the field during the entire season, who checked the survey, and at the same time 5 per cent. of the record entries. The camp officers were also out frequently, and I myself when not kept at my head-quarters for office work was out among the men listening to complaints and seeing to the progress of the work.

Native check.

In addition to the check of 5 per cent. by European assistants, 20 per cent. of the records were checked by the *munsarims*. All complaints, however trifling, were listened to, and access to the papers were given to the ryots, so that opportunities for bribery might be taken away. Generally the complaints were found to be groundless, but occasionally it was found that disputes had not been entered, and in such cases punishment was awarded at once.

The inspecting arrangements for next season have been modified and made stricter to still further reduce openings for bribery, and I trust the records will be in consequence still better.

We had great difficulty in working out for adoption a procedure which would enable the survey and the settlement staff for attestation to be out of the tahsil within the year, and which would at the same time permit of the attestation being done *on records with areas*.

We held many conferences during the field season, and it was only towards the end of January 1884, when the field season was half over, that we came to a final conclusion as to what was best to be done.

The new procedure necessitated quite a novel arrangement during the recess, which has so far answered well, although it has its drawbacks. In order to complete the statistics, an establishment under an Assistant Surveyor was left at Gorakhpur, and thus the carriage of a number of settlement records to recess was saved. Mr. Shaw volunteered to remain; and you were good enough to commend him for his zeal, which he well deserved. He had great difficulty in procuring an office, and had in consequence to hold it in camp till just before the rains set in, when he succeeded in getting a house. I think a similar arrangement must be adopted for the future, as its advantages greatly outweigh its disadvantages, and the native establishment much prefer it.

No account has been previously given of our office procedure by which the records are completed for the settlement officer. The following is briefly extracted from a note by Mr. Little in charge of camp No. 2: the several stages are—

Account of the office procedure.

The dispute list and completed Urdu *khasra* and the soil map having been returned by the Settlement Department—

(1) The Urdu and Hindi *khasras* with their *saffawar* (abstract) and *milan khasras* are first completed with areas.

(2) The areas having been entered in the *parcha jamábandis*, the entries in them are compared item by item with the *khasra* to make sure that they are identical and that every item has its *parcha*.

(3) The *parchas* are then totalled and arranged alphabetically and by tenures in *thoks* and *pattis* into which the *mahal* is divided.

(4) The totals are abstracted into the *terij*, and a grand total having been made, it is checked by comparison with the *saffawar* and *milan khasras*. Column No. 6 of the *milan khasra* checks the cultivated area and column 14 of the *saffawar khasra* checks the uncropped land, the details of the latter being compared with the columns of similar details in the *milan khasra*. If a discrepancy becomes apparent, the error is searched for till found.

(5) The crop statement is now prepared by picking out the areas under different crops from the *khasra*, the cropped areas in the two harvests being checked by columns 9 and 11 of the *saffawar khasra*.

(6) The soil statement is next prepared by extracting the areas held under different tenures and under various soils from the Urdu *khasra*, also the irrigated and unirrigated areas under various soils; the former are checked from the *terij* totals of *sir* land, &c., and the latter from the totals of the same headings on the *milan khasra*.

(7) The area statement of castes is prepared by extracting from the *terij* the areas held by the different castes, and checking the totals by the total in that paper.

(8) The agricultural statistics are collected by the survey staff; the number of wells is checked by the numbers in the *khasra*, and the area irrigated by wells is taken from the *milan khasra*.

The European superintendence over this work is a guarantee that it is done honestly, and the procedure described above multiplies checks on the areas.

Instead of adding any descriptive account of the country surveyed, which is already fully described in the *North-Western Provinces Gazetteer*, I will here give a few statistical extracts from the statements attached to this report (not printed) which I deem will be of some interest.

Some important statistics of the Deoria Tahsil.

The Deoria Tahsil, comprising the one pargana of Salempur Majhauli, and the records of which have been completed for assessment purposes, has an area of 375,560·75 acres, or 586·81 square miles, by the summation of the fields contained in it; this includes an area of 6,124·44 acres of the Gogra river; the boundary of the district being taken as mid-channel. The pargana is divided into 23 *tappas*, containing 1,455 villages, which are held under the following proprietory tenures:—

1088	are	"Pattidari Na-mukamil."
25	„	"Pattidari Mukamil."
2	„	"Bhaya chara."
112	„	"Zemindari wahid."
228	„	"Zemndari bilijmal."

Of the zamindari villages many belong to the Rajah of Majhauli's estate, at present administered under the Court of Wards. Of the total area 289,117·11 acres are under crops, 44,023·19 acres are culturable and 42,420·45 acres are barren.

The irrigated area comprises 153,140·98 acres, of which 124,036·17 acres are irrigated from wells. Proprietors themselves cultivate 92,649·71 acres. There are only 187 ex-proprietory tenants under Act XVIII of 1873 cultivating the small area of 567·91 acres; 3,597 tenants hold 5,839·01 acres rent free. There are 103,342 occupancy tenants who cultivate 126,976·76 acres, and 82,744 tenants-at-will holding 62,972·71 acres. Of the 9,482 masonry wells only 2,124 have been built during the last 10 years.

There are no less than 2,989 inhabited sites in the tahsil, or 5 in each square mile; there are 42,028 ploughs and 86,468 plough cattle.

The area under kharif crops is 173,220·74 acres, of which rice occupies 51,817·83 and kodo 50,762·15 acres, and arhar with kodo 27,424·02.

The area under rabi crops is 159,151·55 acres, of which barley occupies 70,543·66 acres and wheat and barley 33,659·76; the area which bears a double crop during the year is 43,255·18 acres. The food crops in the kharif cover 150,310·42 acres and in the rabi 147,222·33 acres, the whole area covered by food crops being 297,532·75 acres.

Out of a total of 124,645 cultivators, 27,573 are Brahmins, cultivating 75,503·16 acres, and 12,452 Rajputs with 44,792·65 acres; of the other castes, the Ahirs number 16,574 with 35,965·71 acres, and the Koeris 13,502 with 30,856·44 acres of cultivation. There are only 3,483 Mahomedans, and they cultivate 6,032·66 acres.

Of the soils *doras*, elsewhere generally known as *domat*, is the prevailing natural soil, and out of the total cultivated area of 289,117·11 acres it covers 170,260·53 acres; the *goind* or home lands occupy 56,799·16 acres (or about 20 per cent. of the whole), of which 19,361·47 acres are cultivated by proprietors and 37,437·69 by tenants.

I have purposely extracted the above statistics not only as being interesting, more especially to revenue officials and as famine statistics, but because they so clearly illustrate what the work of the party has been. It is not too much to say that in all probability these statistics, owing to their having been extracted in the professional survey office, will be found reliable in a degree that such statistics cannot usually be.

Major Barron's Manual for settlement and survey.

Major Barron's Manual proved an invaluable guide to us, but owing to modifications in procedure a good many alterations in the book are necessary, and, as sanctioned by you, it will be finally corrected during the next recess.

List of records for Settlement Office.

The following records for every village have been made over to the Settlement Department of the Deoria tahsil, which contains 1,455 villages:—

1 Soil trace in Urdu.
1 Ditto in Nagri.
1 Urdu *khasra* with *safawar* and *milan khasra*.
1 Nagri ditto ditto.
1 Dispute list.

Jamabandi slips.

1 *Terij.*
1 Crop statement.
3 Soil statements.
1 Caste statement.
1 Holding statement.
1 Statement of agricultural statistics.
28 Tappawar statistical statements in English in 2 sheets.
1 Abstract of the above by *tappas.*

Training of patwaris.

I may here mention that knowing what importance is attached by the Government of India to the training of *patwaris*, at the beginning of the season I offered to utilize these men for survey purposes and to train them. But the settlement officer was of opinion that they could not do more than they were doing, and that once the professional records were in their hands there would remain little for them to do, and that little they were already qualified to perform.

I would wish you to understand, however, that I am prepared to train *patwaris*, or to survey the country with their assistance as surveyors if required to do so. Whether such a survey could be a success the trial could soon prove.

Aid given by Settlement Department.

To Mr. LaTouche we are indebted for helping us to overcome all difficulties, and now that he has shown us the way, I hope we will be able to walk alone better and to do justice to the important work entrusted to us.

To the Collector, Mr. J. Kennedy, also our acknowledgments are due for all the help he has given us, more especially during Mr. LaTouche's absence in England on six months' leave.

Extract from the Narrative Report of MR. E. C. BARRETT, *Deputy Superintendent, Survey of India, in charge No. 6 Party, Kamrup Revenue Survey;—season* 1883-84.

Examination of field registers.

ON the completion of a village the *khasra* and *dag chittas* were forwarded to the survey camp, where the two records were compared by competent survey and settlement officers, and a list of discrepancies forwarded to the inspector and *munsarim*, by whom all differences were adjusted in the field. The *khasra* and *dag chitta* having been signed in turn by the inspector and *munsarim*, were forwarded, the former to the survey office, and the latter to the settlement office. The field areas were now calculated and entered in the *khasra*, and a trace of the field plan was prepared. Both trace and *khasra* were forwarded to the settlement office for examination and attestation.

Revision survey.

A comparison of the areas and classification of all holdings by the professional survey, with those given in the old settlement records, was made in the settlement office. All differences were noted as "points for enquiry in the field" which were made over to a revision party for examination and report. A revision party consisted of a settlement *munsarim* and a survey inspector or sub-surveyor. The duty of the *munsarim* was to ascertain the true limits of the holdings marked for examination, and to endeavour to account for differences. He had to attend to objections, and otherwise to assure himself that the *khasra* was a complete and accurate record of existing rights. The sub-surveyor attended the *munsarim* in all his investigations, and, when necessary, corrected his trace, making a report on each case to the Survey office. After verification of the changes made by the *munsarim* and inspector, a statement showing the required alterations in the original survey record was drawn up by the Settlement, and forwarded to the Survey office, where the necessary corrections were made, and the records considered as finally passed. In Major Barron's "Hand-book of Instructions" attestation of the records is done previous to the entry of areas in the *khasras*. In Kamrup it was found advantageous to enter the field areas before attestation. Owners were able to compare the new with the old areas of their holdings, and if so minded to raise objections which were at once enquired into and disposed of. The new system worked expeditiously, and gave satisfaction to all concerned.

Survey classes.

The cadastral plans and *khasras* may be accepted as absolutely trustworthy records of possession and rights during the year of survey. The intention of Government is that these records should be brought up to date year by year by *mundals*, who will be provided annually with photo-zinco copies of each village in their respective circles, on to which all changes and additions that may have occurred during the preceding twelve months will be entered. It is obviously necessary that before a *mundal* can perform this duty he must have some knowledge of field surveying. It was with a view to training a body of men capable of doing the work that survey classes were established at Barpeta and at Gauhati. On the arrival of the survey party in Kamrup, the Barpeta survey class was brought to Rangia and placed under the charge of the Deputy Superintendent of Survey. This class passed 29 pupils, natives of Assam, in surveying during the season. The result is undoubtedly small, but a start has been made, and better results may be expected during the ensuing season. The Director

of Agriculture had offered rewards of Rs. 25 to each *ámin* who would pass his *mundal* in surveying, with a view to securing the efficiency of the existing establishment of *mundals*. At the close of the field season it was found that 12 men were sufficiently advanced to be able to pass the required examination.

Lakhiraj and nisf-khiraj estates and waste-land grants.

The boundaries of all Lakhiraj and Nisf-khiraj estates and of waste-land grants are shown in the plans. The survey of these holdings was started by the professional survey under Mr. Patterson in November 1875, but the work was subsequently made over to Baboo Futtack Chundra Barma, Extra Assistant Commissioner, by whom the survey was brought to a close in July 1883. The result of the examination of Lakhiraj and Nisf-khiraj survey areas with those of the cadastral survey shows a very near approximation to accuracy in the total areas of holdings; considerable differences in classification, however, appear at times. These may possibly be accounted for by changes that have occurred since the earlier survey was effected. The Settlement office has been furnished with detailed areas of all lakhiraj and nisf-khiraj holdings, apart from those given in the village *khasras*.

The area cadastrally surveyed contains	46	lakhiraj	estates, area	6,975·67	acres.
517	Nisf-khiraj	estates, area		41,125·12	„
2	Waste-land	grants, area		455·00	„
Total of lands held rent-free or at privileged rates ...				48,555·79	„ or 75·87 sq. miles.

Extract from an account of Dardistan, surveyed during 1882-83 *in connection with the Trigonometrical Branch Survey of India.*

NATURE OF COUNTRY, TREES, PRODUCE AND CATTLE.

THE country is mountainous, and the ground rugged and stony. The mountains are arranged in ridges, and rise, in some cases, to 16,000 feet; the stone of which they are formed is in no way serviceable. Open *maidáns* exist in a very few instances, and the tops of the mountains consist mostly of precipitous peaks. Vegetation is met with only where there is running water; otherwise the country is dry and barren. The higher ranges are well covered with grass and forest, and afford pasturage for goats and sheep. The forest trees consist mostly of *chir*, *kachil*, *chalghoza*, pencil-cedar, and birch. *Chir* and *kachil* are used to cover the roofs of buildings. Weeping willow and *bani* trees grow both in the forest and in the cultivated fields. The latter is of a roundish shape; its leaves are of a dark colour, round, and about an inch in diameter. They are to be had fresh and green from the tree at all times of the year, and afford food for goats. A fine thorn, about ½ of an inch in length, grows along the leaf. Grass does not grow below the height of 10,000 feet, but the pencil-cedar is met with more or less at this height. From the height of 12,000 to 13,000 feet, the mountains are covered with small shrubs instead of trees. The principal of these are known as *mithári*, *beúnbiár*, and *sosar*. The *mithári* bush does not rise high above the ground, but spreads out laterally; its leaves resemble those of the *kachil*, and its wood that of the pencil-cedar. The wood burns well even when not dry, and the weight of an average sized bush is about 20 *seers*. The *beúnbiár* rises about two or three feet above ground. Its leaf is like that of the weeping willow, and its stem is of about one finger's thickness. The leaf of the *sosar* is about ½ an inch long, and is hard like that of the *hina* (*Lawsonia inermis*); it gives out an agreeable smell, and does not rise much above the ground, but spreads about; its leaves, if put among woollen clothes, will preserve them against insects. There is no timber trade carried on in the country.

The snow disappears entirely in summer. No cultivation is carried on on the mountain tops, but in the vicinity of each village sufficient to support the inhabitants is raised. The grain produce consists of wheat, barley (of two kinds, one the common sort, and another without husk, like wheat), *bákla* (a bean), *china*, *turumba*, *kangni*, and *maki* (Indian-corn). The land is prepared for wheat in the beginning of September, and the seed is sown at the end of the month. The crop is ready in the month of May following, when it is reaped. The other sorts of grain are sown in April, and their harvest time is in the following September.

The cattle stock consists of cows, bullocks, goats, and sheep; there are no horses in the country, but asses and buffaloes are met with in some places. Ordinarily one family possesses four or five cows, a pair of bullocks, and fifty or sixty goats and sheep. A man who has only one bullock, borrows a second from some other person, and returns the obligation by serving that person for double the time he keeps the bullock. Bullocks are used only for cultivating the land. They and cows are generally of a dark colour and small size.

It is not customary to milk the cows. The milk of the goat, which is in general use, is thicker, and tastes better than that of the cow, and comparatively a greater quantity of butter is produced from it. Butter is made from milk which has been kept for 24 hours

MAP OF

DÁRDISTÁN OR SHINÁKI

INCLUDING

CHILÁS

DÁRDISTÁN
SHINÁKI
CHILÁS
INDUS R.
GILGIT
Patiál
Mánkiál
Budankot
Biriokot
Dúdokot
(Samagial)
Phogaj
Gaiáh
Sazin
Shatiál
Harban
Thur
Thak
Bunar
Datuchi
Deobani
20154
BUNJI 14831
Chhamuri
15341
Hatú Pir
10254
RAMOSH
Haruchal
Maruk
Shite
Hodar
Thalpen
Darachhe
Singal
Dainrai
Halole
Gaslai
Kalbai
Manglech
Khabbahs
Kotswra
Dudhar Sar
Sar
Gali
Gilgit
Khomar
Jutial
Yachrot
Harai
Kharet
Marang
Gabar
Mákhel
Türe
Ketgala
Shaiah
Harban
Dúdiahal
Khanbar Nala
Totambat
Sheithar
Dachar
Singal
Manuhai
Kotswra
Dudhar Sar
Thak
Bunar
Halole
Gaslai
Kalbai
Manglech
Diamrai
Chhamuri
Hatú Pir
Shochhar Pass
Datuchi
Deobani
BUNJI
Haruchal
Maruk
Shite
RAMOSH
Thalpen
Darachhe
Singal
Dainrai
Halole
Bunar
Gaslai
Kalbai
Manglech
Khabbahs
Kotswra
Dudhar Sar
Thak

in a goat or sheep skin, by shaking it for about 3 hours and putting in some water at intervals. The milk thus agitated is afterwards put into a wooden vessel and the butter is separated, the milk being used either alone or taken with bread. The butter is collected into a lump of about 25 seers, wrapped round tightly with the bark of the birch tree, and then deposited in the earth, to be taken out on occasions of feasts. It becomes black shortly after being buried, and smells very offensively, but the people of the country eat it with much relish. The older the butter the more it is liked, and the man who possesses it is considered a great personage.

The price of a bullock, or of a cow with a calf, or big with calf is one *tola* of gold; other cows can be had for half that price. The goats are of every colour, and of small size; their coat is short. The price of a common she-goat is one *sone* rupee, and that of a he-goat three *sone* rupees. The sheep too are small in size, and have small tails; they are not so numerous as the goats: their wool is made into cloth. The price of an ewe is a *másha* of gold, and that of a ram two *máshas*.

Religion, Customs, Dress, Arms, Dwelling-places and Commerce.

The people of the country are Mahomedans of the *Sunni* sect. Seven generations previously they were all Buddhists. They were persuaded to embrace *Islám* by the *Mullas* of Kághán and Kashmir. They divide themselves into four castes: *Shín*, the most respected of all; *Yashkun*, the second; *Kumin*, the third; and *Dom*, the fourth in order.

The men as well as the women are of a moderate height, healthy, and of fair, florid complexion; have short fat necks, broad chests, and muscular legs. The men fight well from behind rocks, but will not stand for a moment in the open. They are strong enough, but cannot stand hard labour or anything which they are not used to. They are not wont to travel, and are especially very backward in carrying loads. One man can with much difficulty carry 20 seers for one march.

They never willingly travel under a hot sun; when they go out, they do not take any cooking utensils or anything that might be useful or make them comfortable; even salt is neglected, and they are content with some clothing and flour as their sole provision against necessity during the journey. They make use of large stones in place of vessels, and bake their heavy loaves (sometimes a seer in weight) in hot ashes.

As to arms, each man as a rule possesses a sword and a matchlock. Some have daggers, but not as a rule; bows and arrows are also used in some of the valleys. In general their arms are old, but whoever purchases new ones chooses those made in the Panjab or Kashmir. Repairs to them are done by the blacksmiths of Dárel, Tángir, and Koli, who visit the country round about once a year for that purpose.

The implements of husbandry are made by the people themselves as far as the woodwork is concerned, but the ironwork is made by a blacksmith. They can all make cups, dishes, and the like from the wood of the walnut tree, and spoons from that of the birch, by turning them on the lathe; but on the whole they are not beautiful. Copper vessels are also in use, but they are never tinned again after the day of their purchase. In fact, the people do not observe any sort of nicety in preparing their meals; they possess no taste for the table, and merely care to fill their stomachs in obedience to the call of nature.

They make their dress from woollen and cotton cloth: the former is spun at home and the latter purchased. The women in general, and some of the men, make clothes for themselves. A man's cap consists of a bag, about 10 or 12 yards long, with the mouth rolled up: the folds serve as a place of deposit for tobacco, needle and thread, and money. On the body is worn a loose sack reaching down to a little below the knees, and under the sack a pair of trousers, loose at the ankles. Besides this a *choga* (over-coat), hanging down to the ankles, with sleeves moderately loose and about a yard long, is worn when needed. It is invariably made from *pattu*. The caps of the women are made of black *pattu*. They are of a roundish shape, very loose, decorated with shell buttons and red gems, and in fact of quite a different fashion from those of the men. The sack reaches down to a little below the knees with loose sleeves about ¾ yards long. In lieu of a pair of trousers, the women wear *ghutanna* (half trousers) from knees to ankles, and tight at the latter. Now and then a sheet of cotton cloth or of sheep or goat skin is worn over all. On a journey the men wear sheep or goat's skin fastened round their legs from knee to ankle, and also on their feet. Women always go barefooted. They have no ornaments of gold and hardly any of silver. In the *binagosh* (cavity at the lower part of the ear) they wear brass or silver rings with three or four artificial pearls or coral. Their necklaces consist of artificial coral, or beads of agate, and such like tones. Their finger rings and bracelets are chiefly made of brass or bell-metal; the forme are sometimes made of silver also.

The women wear their hair either all plaited in a single tail at the back, or let it hang over their shoulders in two plaited masses. They never decorate themselves; on the contrary they always wear dirty and patched up clothes. Bathing is very seldom resorted to; even washing of the face is looked upon as an unpleasant task. The men, however, are not quite so dirty: they wash their clothes now and then. They generally shave their heads and wear long beards with moustaches cut to a moderate size.

The walls and towers of their forts are built of rough stone and mud, as are also the dwellings within. The walls of the houses, or rather enclosures, are not higher than 7 or 8 feet. The roofs are covered with *chír* or some other wood of that kind. The houses have either a very small courtyard or none at all; are very small and built close

to each other for protection against cold; they are sometimes two-storied. Two or three families, closely related, live in the same enclosure. The forts will stand musketry fire, but not that of guns.

Disputes of all sorts are generally settled by the headmen of the different places, who receive no allowance for their labour, nor are exempted, even in part, from paying their share of presents made annually to the Máháraja of Kashmir, but are held in higher respect than others. An appeal from their decision is made to the headmen of Chilas, but cases of importance are sent to Gilgit for final decision. The common mode of punishment in this country for quarrels of an ordinary nature is, to make both the parties give a feast to the whole village, that is, each provides food for half the inhabitants, women and children included.

English and Kashmir coins are very little used. In transactions among themselves the people use their own *sone* rupee (equal to one *másha* of gold and valued at 1½ rupees of the English coin). They much prefer gold to coined money, and never give it to a foreigner except in exchange for articles (cloth, vessels, tools, &c.) of English or Punjab manufacture, or salt; when they calculate the value of their one *tola** of gold at Rs. 12 of Indian money. Copper coin and shells (*kori*) are nowhere used in the country. There are very few tradesmen indeed, all live by cultivation. The people of Koli, in Kohistan, come here for the purpose of trade, and have even settled in some places.

Oil is not used at all, either in the kitchen or for lighting purpose. A burning piece of firewood serves for a lamp. Its smoke, however, blackens not only their clothing, but also their faces. When asked if the black spots on the faces of the women and children could not be washed off, the people said that they could be, but it was against the custom and practice of the country.

Wheat and *maki* are sold at 20 *topas* for a *sone* rupee; barley, *chúna*, *turumba*, and other coarser grains at 23 *topas*; and *ghi* at one *doru*. A *topa* is a wooden measure which contains 1½ seers of grain. A *doru* contains about 2 seers of *ghi*. Besides *topa*, a *sin* and a *kút* are used in measuring the grain. A *kút* is equal to 6 *topas*, and a *sin* to 20.

Peshawar salt is used throughout the country, and is brought from the Swat side. *Gur* and sugar are unknown, and grape juice supplies their place. The use of wine or any intoxicating substance is considered a sin, alike with theft and gambling. Adultery is very rare, and people found guilty of this crime are invariably punished with death.

Marriage ceremonies are performed in the beginning of winter. Boys of 15 or 16 years of age marry girls of 12 or 13; as a rule, each man has one wife, but a second wife is not very uncommon. The people of the *shin*, highest caste, contract marriages in general among their own caste, but the practice of marrying boys of the *shin* caste with girls of the *yashkun*, the next lower caste, is not entirely prohibited: their offspring, however, is not held in the same consideration as that of pure *shins*. The *yashkuns* marry among themselves. In the two lower classes, *kamin* and *dom*, marriages are contracted between the two castes, as well as in the same caste. The people in general do not care about saying daily prayers, but they observe the *Ramazan*, and the women do not practice *pardah* as they do in other Mahomedan countries.

In the beginning of winter a sort of fever breaks out in the country, which often causes great mortality. The treatment resorted to is bleeding in the arm. When the head aches severely a little blood is taken from the forehead between the two eyebrows. In addition, some medicines are made use of, but their names and description could not be obtained.

Narrative Report, dated 18th November 1884, by W. H. Cole, Esq., M.A., *Officiating Deputy Superintendent, 3rd grade, on the operations of the detachment in Kashmir and on surveys in the Kishanganga valley for the six months ending 30th September 1884.*

This small detachment, which was last year employed chiefly in making a survey of Chilás from the surrounding mountains, was this year directed to continue the revision of the survey of the Kishanganga valley in Kashmir.

The original survey of this valley was made in 1860 under somewhat unfavourable circumstances, and a revision had for some time been thought necessary. A tract about 600 square miles in area in this valley was revised by Ahmad Ali in 1882, and a small portion in 1883. He has now completed the revision of the whole basin nearly down to latitude 34° 30′, with the exception of the small Jagrán Dara. This he was obliged to leave owing to the setting in of snow.

Ahmad Ali left Dehra Dún on the 2nd May for Srinagar, where some days were spent in laying in supplies and making necessary arrangements: he then proceeded to Gures, where he arrived on the 29th. The snow still lay thick on the hills, and he was unable to commence work until the 10th June. Between the 10th of June and the 15th August he surveyed from Gures up the Burzil valley to the Burzil pass on the north, to the Gugai pass on the west, and the Parashtkhar and Buroh passes on the east, as well as a portion of the Tilel pargana. By the end of September he had finished the valley in which the Kishanganga takes its rise, and had surveyed to the west of Gures as far as the Machhil Dara. From here

* A *tola* is equal to 8 *máshas*, and one *másha* to 9 *rattis*.

he continued his work westwards. Towards the end of October snow began to fall, and by the 12th November he was obliged to close work, having, however, very nearly completed the whole of the work assigned him and topographically surveyed 2,100 square miles on the ½ inch scale.

Besides the revision of the topography, he has taken many angular observations for fixing additional points to those previously determined trigonometrically, and he has also observed a number of heights.

The stations visited varied from 13,000 to 16,500 feet above sea level, at most of which the observations necessitated a stay of two to three days, the observing being much delayed by cloudy weather. To the end of August the mountains all round remained covered with snow, and, as nothing but a white expanse was visible on all sides, it affected his eyes and brought on ophthalmia. This continued to trouble the Sub-Surveyor for a long time, and he has not yet quite got over the effects. Most of the stations being far from the habitations of men, supplies had to be carried with the party, and fuel had to be brought up from the valleys. In one case, misled by the old map, which showed a path where none was found to exist, much time was lost in trying to cross over the range between Nagai and Tilel, and finally the circuitous route by Shingo valley had to be adopted; provisions ran short, and for three days the party had to eke out their small stock of flour with wild vegetables. After August the snow melted, but the air became colder, and then also water, which the snow had before supplied, had to be brought up from the valley.

The Sub-Surveyor having only just returned from the field, there has been no time to make any close examination of his work. His topography appears to differ in several minor features from that hitherto shown on our maps, but there are no serious discrepancies. He shows a large increase of villages, which is an important addition to the old work.

He appears to have worked hard and well, notwithstanding having to submit to several hardships, and he deserves a good deal of credit for his work.

The country surveyed is, roughly speaking, comprised within the parallels of 34½° and 35° and the meridians of 74° and 75¼°. It is bounded on the north and south by the water-shed of the Kishanganga river and towards the eastern extremity, where the river has its source, is very elevated, the ranges on either side being covered with perpetual snow. In the south-eastern corner of this region are several glaciers, none of which, however, are more than about a mile in length by half a mile in breadth. The valley of the Kishanganga, within the limits so defined, consists of the parganas of Tilel, Gures, and Shárdi; of these, the first two form a part of the Iskardo district, the last that of Muzaffarábád. The transverse valleys are in general open, the hill sides, with the exception of the high ranges, which are covered with snow, are clothed with grass and forest trees, and are used as pasture grounds. Only one crop, consisting, in the case of Tilel and Gures, of either barley, peas, "*turumba*," "*china*," or "*kangni*," and in that of Shárdi of peas, Indian corn, or some paddy is raised in the year. The yield in the first two parganas is insufficient for the wants of the people and food-grain has to be imported. Sheep, goats, cows and horses, and in Shárdi buffaloes also, are reared. Honey is largely produced in Shárdi; the bees are here domesticated, and a portion of their produce sent as tribute to the State. Only a few fruit trees are met with, and those below Shárdi.

In Tilel and Gures the inhabitants live in villages, while in Shárdi detached houses in fields here and there are common. In the former parganas a single family lives in a house and the custom of polyandry prevails: in the latter, two or three families live together in one house. The number of villages with the total number of houses in each pargana and the revenue paid to the State is as follows:—

	Villages.	Houses.	Revenue in chilka Rupees.*
Tilel	25	175	1,800
Gures	25	225	2,250
Shárdi	93	350	8,000

The inhabitants are well-built and middle-sized; they are Muhammadans of the Sunni sect. The language spoken in Tilel and Gures is Shina; that in Shárdi is the same as that spoken in the hilly tracts of the Punjab. In the first two parganas a cap, a long loose coat and *paijámas* (pantaloons) form the dress of the males as well as females, the only difference being in the cut of the *paijámas*, which are loose for the males and tight fitting for the females. In Shárdi, a turban instead of a cap, and a shorter coat are worn. The people are not traders. They manufacture their own cloth, from the wool of their herds, their agricultural implements, and utensils for domestic use. Salt only is imported from Kashmir, and that of an inferior kind for cattle is brought from Iskardo. The people are unarmed.

On the south several passes; of these, that of Satasar from the pargana of Tilel, those of Rájdaiángan and Gusai for Gures fort, of Naunár and Soidúr from Machil, and of Sonápind and Pathre from Shárdi leading into the Kámráj Iláka of Kashmir, are well known and much used. They are all practicable for beasts of burden, the road over the Rájdaiángan in particular being kept in good repair. On the east the passes of Káubal or Káukhon, Buroh, Parasht Khar, and another one near the Burzil pass lead to Iskardo; of these only Parasht Khar, on account of a dense forest on its western side, is impracticable for beasts. On the north the passes of Burzil, Kamri, Shochhar, Kamukdori, Duarian

* One chilka rupee=10 annas of Anglo-Indian money.

and Luiát lead to Astor, Chilás and Kághán; the first four of them are practicable for laden animals, while the others are not difficult; but as no traffic is carried across them, they are not cared for. The path along the Kishanganga river, with the exception of the portion between Gures and Shárdi, is good. In Tilel and Gures, wooden bridges, where necessary, are constructed over the main and tributary streams, but in Shárdi rope bridges are common.

The Rájdaiángan pass, by which the Kishanganga valley was entered, was reached about the middle of May. The pass was then found covered with some 30 to 40 feet of snow, the upper layer (of 2 to 3 feet) of which was soft and made the passage difficult. It took two days to get over an ordinary day's march, and even then some of the baggage had to be left behind.

Extract from the Narrative Report of LIEUT.-COL. H. C. B. TANNER, S.C., *Deputy Superintendent, Survey of India, in charge Darjeeling and Nepal Boundary Surveys;—season* 1883-84.

Sikkim Survey.

MR. ROBERT started for North Sikkim last October, accompanied by Rinzin Nimgyl, a Sikkim guide and surveyor, and returned to Darjeeling in the December following, after having completed in a most satisfactory manner the remaining unfinished portions of Independent Sikkim. He also revised and amplified Captain Harman's work, which was surveyed on a smaller scale than the rest of the country. The survey of this interesting section of the Himalayas has been going on in a desultory way for the past 20 years, and I have much satisfaction in reporting that it has now been completed, and that the maps, most skilfully and artistically drawn by Mr. Peyton, are nearly ready for publication. These maps, three in number, embrace a tract on which several surveyors and others from time to time have been engaged. First and foremost came Dr. (now Sir Joseph) Hooker, who about the year 1842 made a reconnaissance survey of Sikkim and a portion of Eastern Nepal. His sketch extends from the Donkia and Chola passes on the north-east to Khambachen and the Wallanchoon passes on the north-west. Hooker's sketch remained untouched until Lieutenant (now Major) Carter, R.E., added to it by his reconnaissance survey of the country between Darjeeling and Tumlong, which was executed during the march of Colonel Gawler's force in 1861. The survey of Independent Sikkim was again resumed by Captain Harman, R.E., in 1878, and, as now reported, was completed by Mr. Robert, Assistant Surveyor, in the winter of 1883.

At the Donkia (Donkhya) pass Mr. Robert was met by a large party of Tibetan officials and soldiers from Khamba Jong, who treated him with more respect and civility than hitherto it has been their custom to accord to European travellers who have happened to visit the frontier.

It is unfortunate that, although both Sir Joseph Hooker and Captain Harman had visited the Donkia pass previous to Mr. Robert's expedition, yet neither of them were so fortunate as to fix any of the great snow peaks in Tibet. Mr. Robert was equally unsuccessful, for, though with his theodolite he intersected a number of lofty mountains, he saw none of them again from any other point of view. Captain Harman described to me the snow panorama he saw in Tibet as "immense," and Hooker's little sketch quite confirms this. Countless ranges rise one behind another until they are lost in an unknown and remote distance. Some five or six fortunate Europeans from time to time have made their way to the now well-known Donkia pass, but except Hooker, none of them, so far as I am aware, have brought back even an outline sketch of the grand panorama of the Tibetan snowy ranges visible from that place.

Mr. Robert visited the Giagong-Donkia boundary on the Lachung river, which is the most northerly position he reached. It is here that the boundary claimed by Tibet crosses the Lachung from east to west, and beyond this no European is allowed to travel. Hooker escaped over the so-called boundary by a ruse, and got round the Cho-la-mu lakes to the Donkia pass by riding faster than the Tibetan guard could follow him on foot. Mr. Robert saw the lake, the limits of which he fixed by rays. Both Hooker and the Lama have also laid down these lakes; but all these authorities differ as to the size of the sheet of water, and this is because the banks shelve so imperceptibly that a very slight addition to the quantity of water makes a very considerable difference in the area which it covers. The same remark explains the reason of the very considerable discrepancy in the size of the Kalo-cho and Kham (or Bam) Cho on the maps of Captain Turner (1784), explorer "L" and the Lama. In the Tibetan winter there is very little flowing water, except in the large rivers, for all nature is frozen up; but in summer the melting snows and a moderate rainfall are quite sufficient to account for the variable size of the Tibetan lakes at different seasons of the year. Mr. Robert has brought back the unlooked for intelligence that to the north-east of Kinchinjinga, that is, on the shady side of peaks and ridges which vary from 23,000 to 28,000 feet, and which are nowhere under about 20,000 feet, there is not a single glacier. Masses of glacier ice and *névé* skirt the lower slopes, but in none of the valleys does the ice flow away to any distance from the immediate foot of the mountains. Hooker's picture of Kinchinjinga shows an insignificant glacier which extends for a short distance from that peak, but as a rule the whole of the enormous mass of snow which is depicted on the slopes of the Kinchinjinga group is either evaporated where it falls, or else

is melted and carried off by the Lachen and other feeders of the Teesta without having first passed into the state of glacier ice. In clear weather small glaciers may be seen from Darjeeling at the foot of Kubroo, and I have noticed a great extent of glacier ice between Kubroo and Junnoo, but it hardly reaches the valleys. In fact, Kinchinjinga may be said to have no glaciers worthy of the name, and certainly none half the size of those given off by a Gilgit mountain of the comparatively low altitude of 18,000 feet. A very few days ago I was looking straight up a valley to the very base of Mount Everest, and there also I could not detect glaciers of any noteworthy size. Along the Nepal snowy ranges for a hundred and fifty miles west of Everest, I have closely examined the valleys with rather high telescopic power, and, except on the lower slopes, I can discover no glaciers.

Mr. Robert made his way for a considerable distance up the streams which drain the eastern face of the Kinchinjinga group, experiencing the same difficulties and hardships described as being met with by Hooker in that locality. The dense growth of stunted rhododendron in the Zemu valley was found to be a very serious obstacle. The source of the Zemu was found to be in the range which runs north, and a little east from the summit of the Kinchinjinga, thus necessitating a large correction in the last published map of this region, which depicts it as rising many miles north-west of Kinchinjinga.

The valley of Talung, which is the only one in all Sikkim that has not been visited by a European, was explored by Rinzin Nimgyl, who surveyed the habitable part of the valley by plane-tabling and sketched in the remainder approximately. He fixed the position of the Talung monastery, which contains, I understand, certain relics of the family of the Sikkim Raja, in whose eyes it appears to be especially holy, and a certain mystery attaches to the place. Hooker tried, but was unable to visit it. Captain Harman made an attempt to reach it, but the people fearing his intrusion cast stones down the mountain sides and forced him to turn back, which he did at a point where the road is confined between rugged cliffs. Should any one propose to visit Talung, he is generally put off by the exaggerated accounts given by the people and Sikkim officials of the dangerous passage along the scarps which wall in the defile from which Captain Harman was driven back.

Near the two heads of the Talung valley are two roads; one leads over the Eincha-La pass to Alathang (or Alak Thong), and thence to Jongri, and the other by a pass without name to the Zemu country. The former of these has been visited by Dr. Simpson, and is said to be almost 17,000 feet in altitude, but Talung has not been reached by this pass for many years, and never by an European. The road when in use was difficult, but now it has become almost impassable, and is choked up with glacier ice and *névé*, and the slight track which once existed has been lost. The nameless pass above noted is situated immediately to the west of the well-known and picturesque peak D[x] or Simolchum, and is about 17,300 feet in altitude, appears open and easy, and the south side only partially covered with snow fields, but it is said not to be used. There is a third pass leading over the range north of Talung which is much frequented and is a good road for yaks. Its height has not been ascertained. There is no pass whatever out of the Talung valley towards Pamionchi and Tassiding, the cliffs on the Pandim Narsing range, and its southern continuation being quite inaccessible. Viewed from Darjeeling, the range is seen to consist of a series of immense pointed splinters of rock, streaked here and there with fine lines of snow. In company with Dr. Joubert I made the attempt to scale this range so as to get a view down into the Talung valley beyond; but after cutting our way for several days through the densest network of rhododendron branches and roots, we were stopped at the edge of the snow by huge cliffs which closed the valley head on every side. The water from the small glacier and from the snow fields above us finds its way through a narrow cleft or gorge down which the torrent thunders in a series of cascades. Except that we enjoyed some remarkably fine scenery up this valley, our journey was a fruitless one. The famous caves of Lhárhienphúk, which we visited, were really not worth going out of our way to look at. We found pilgrims there who had come from Western Tibet to pay their respects to the presiding spirit, but there was no idol of any kind, and the so-called cave was merely a cavity between great masses of rock which had fallen from the mountains above. From all the information I can gather respecting the routes to Talung, it appears that the only one which is at all practicable is that which was attempted by Captain Harman, and it is a thousand pities that his exploration of the mysterious valley was not successful; for had he reached the place, we should now be fully informed of the whole of the topography of Independent Sikkim. Mr. Robert's sketch map of North Sikkim, now being published, is the outcome of a most creditable survey operation performed partly by himself and partly by the late Captain Harman. The notes of the latter lamented officer and of Mr. Robert, which are in my possession, need a more extended notice than they can receive here, and it is my intention to submit them hereafter, when the surveys on the Sikkim frontier now being conducted by Rinzin Nimgyl have been concluded. Rinzin's last report was sent from the Kanglá pass, and I am informed therein that the explorer had already, at the end of October, visited a high peak to the north of it, after having reached Hooker's "Yaloong."

With the exception of a tract to the north-west of the summit of Kinchinjinga, we now have a map of the whole of that great mass of mountain peaks and ridges which collectively go by that name. Many of the different features comprised in the group have names of their own. Of these the principal are Kubroo, Junnoo, Pandim, D[x] and Narsing. It may be said that Kinchinjinga is a better known mountain than any in the Himalayas, and taken altogether it is perhaps, with one exception, the grandest in the whole range. It is regarded by the permanent residents of Darjeeling with admiration that never

pulls, and although it is constantly, in clear weather, a prominent object in their front, the beholder is never wearied of studying the great snow slopes and ice fields which cover its sides. The aspect of the mountain has many phases which constantly alter its appearance from day to day. It is seen to best advantage when its base is veiled in a delicate curtain of clouds, so that the imagination is allowed to magnify the part which is hidden from view.

From Darjeeling and from the Sandukphu range, Kubroo appears as a straight-topped and uninteresting ridge of snow, standing slightly away from the central peaks of Kinchinjinga proper; but at a distance of 100 miles from points in the Purnea district towards the south-west, a telescope reveals the fact that the face of Kubroo presented towards Darjeeling is only one side of a huge snow-clad table-land (24,000 feet), quite smooth at the top with a very slight slope down to the westward. Near the summit Kubroo is very steep, and a considerable scarp bounds the western edge of the plateau, below which extends a long declivity of snow.

To the west, and between that plateau and Junnoo, from the same point of view in the plains of Purnea, with a high power telescope I made out extensive masses of glaciers, and although 100 miles distant, I could still detect the broken character of the ice blocks composing it. Kubroo is connected with the second highest peak of Kinchinjinga (27,815 feet) by a ridge, the very lowest depression in which has an altitude of 22,100 feet. This depression has been accurately determined from several points of view by a trigonometrical observation, and the height I mention is not open to any kind of doubt, notwithstanding that Mr. Graham, the celebrated mountaineer, informed me that it was between Kubroo and Kinchinjinga, over a depression of 16,000 feet altitude, that he took his Sikkim coolies when making the circuit of Kinchinjinga. Junnoo is only partially visible from Darjeeling, but from the Sikkim-Nepal watershed, anywhere beyond Singale La, it stands apart, and forms a most striking object, rising out of snow fields through which sharp needles of rock protrude. The slope of the western face of Junnoo is sufficiently gentle to allow snow to remain on it. Its peculiar outline never seems to vary whether viewed from the Darjeeling, Purneah, or Bhagalpur districts. From the Durbhunga district, after receding 120 miles from Junnoo, I could at last observe to the great chain of peaks and snow-clad ridges which run almost due north from the highest point in Kinchinjinga, and from the great distance mentioned I was still able to fix heights of knolls and depressions. A depression which I observed to the north of a long hog-backed mass of snow may perhaps be the Jinsong La pass, by which the Lama and Babu S. C. D. passed from the drainage of the Arun river system into that of the Teesta, where they experienced great hardships, and suffered much from the effects of rarified air and cold. The Lama informs me that the Jinsong La is the highest point he has ever visited, and that when Mr. Graham made his circuit of Kinchinjinga he must have crossed by the Jinsong La, for it is the lowest depression in the whole range. How Mr. Graham reached his starting point, Jongri, to the west of Kinchinjinga, after making his way round to the east, I have been unable to discover. Mr. Robert has, he thinks, fixed the Jinsong La pass, but he is not certain. It is hardly ever used, either by the people of Khambachen to the south-west or by the Tibetans to the north, its height (about 19,000 or 20,000 feet) being too great for laden coolies of ordinary physique, and firewood or other fuel is far away from it on both sides. It is owing to an error made in the position of this pass by the rough exploration of the Lama and Babu S. C. D. some years ago that the whole of the topography or rather geography of the north of Kinchinjinga has been so much distorted on the last published map. West of Junnoo the range consists of a series of fully clad snow peaks of bold outline, but the passes over the lower and more western extremity of this ridge will probably remain undetermined, unless Rinzin has been able to fix them from the Kangla peak. It is most unfortunate that the position of Junnoo was so much out on Sir Joseph Hooker's sketch map, for it has caused a corresponding error in his topography about Waloon and to the westward. Hooker's Mount Nungoo has been identified and fixed, and I believe that we have also secured the position of the Wallanchoon pass, the base of which was visited by Hooker.

Away to the left (or north) of the third highest peak of Kinchinjinga the mountain falls abruptly, after which there succeeds a portion of the ridge (which is quite flat with a snow cliff at its edge) on which rises a slight rocky knoll, which may be identified from Observatory Hill in Darjeeling, and again with precisely the same outline from the Bhagulpur district. It is immediately to the north of this knoll that a blank exists on the maps, for the details of the range which lies between the great northern spur of Kinchinjinga and the Junnoo chain can be seen neither from the plains of Bengal nor from the Donkia or the Zemu country. It is probable that this unknown tract drains into the Khambachen river. Shortly to the north of the knoll in section 13, which stands on the smooth, flat portions of the Kinchinjinga chain above noticed, the range dips down to a sharp and deep gorge, and immediately rises again almost precipitously to the eastern peak of Junnoo. The gap or depression is 22,500 feet in altitude, and has been trigonometrically fixed.

The well-known Pandim and Narsing peaks are the two nearest to Darjeeling. The former is separated from the main body of Kinchinjinga by the Guicha La pass alluded to before. This subsidiary range has many interesting features which might be dilated on. It has small glaciers which descend to some 14,000 feet. I believe Narsing and Pandim to be inaccessible owing to the great mass of cliffs by which they are surrounded. D^{s} or Simolchum of Mr. Robert is perhaps the most picturesque of all the peaks of Kinchinjinga; it has an exceedingly sharp summit which is just visible from Darjeeling, peering over the Pandim-Narsing ridge. The black rock needles of its base are on the largest scale, and from the Bhutan frontier and that neighbourhood, stand out in bold relief against the very

considerable snow fields on the slopes behind them. Its eastern spur dwindles away gradually until it dips into the Lachen valley, but though the ridge has considerable peaks, they are in no way remarkable either in respect to their height or form. On the slopes of Kinchinjinga, below 16,000 feet, there is a fair amount of game, but so few sportsmen have explored this part of the Himalayas that we are almost in ignorance respecting the beasts which are met with. The Serrow is the commonest animal on the southern slopes. Associated with him are found in no great numbers the Gural, and higher up the Musk deer In the upper feeders of the Lachen and Lachoon, the Ovis Ammon or Barral is not uncommon, but there are no wild yaks. The brown bear, if found at all, is exceedingly rare, and I should say that it only occasionally strays across from Nepal, and does not make Sikkim its home.* Hooker relates that he saw game in plenty north of the Donkia on the flat ground which surrounds the Cholamu lakes, and among the animals he met with were the Tibetan antelope and the small Tibetan gazelle. For a long while I laboured under the impression that the so-called Sikkim stag, or as the Tibetans call it, the Shao, was to be found in the country under notice, but after a careful and searching enquiry I have come to the conclusion that this stag is not to be classed as a frequenter of Sikkim at all. In the Calcutta museum there is a stuffed specimen of this noble beast, and its habitation is put down as being along the Singale La range. I am convinced that he has never been seen in that part of Sikkim, and if he ever enters the country at all it is by one of the eastern passes. The habits of this magnificent stag are described to me to be exactly those of the Bara Sing of Kashmir. In October he gives forth the same plaintive cry which falls so pleasantly on the sportsman's ear in the lovely Kashmir valleys. In appearance he is precisely like his Kashmir brother; only he is on a larger scale. Mr. Robert, I believe, is the only European who has seen the undulating grassy slopes above Chumbi in Tibet where the Shao has his home, and it is from these high lands that in winter he makes his way down to the warmer pine-clad tracts, just as in Kashmir he migrates from the upper into the lower valleys, where he is able to graze on pastures free of snow. The horns of the Shao are difficult to obtain, because there is a great demand for them in China, where they are exported after having been sawn up into convenient lengths. The Abbé Des Godins informs me that the Shao is found in the Alpine regions far past Bathang and Taisain Do (Darchando) and beyond; and the Lama states that in the Upper Lhobrak in Bhutan they are plentiful, but I feel quite certain that between the Chumbi uplands on the east and Kashmir on the west the beast is absolutely unknown. Any one who has visited the Singale La range and the southern spurs of Kinchinjinga between 10,000 and 13,000 feet will perceive at once the improbability of the Shao finding a suitable home in Sikkim. Between the altitudes named, the rhododendron jungle is so dense and impenetrable that no animal could pass through it. The roots cover the ground with a sufficiently intricate network, and the branches of the bushes are so closely entwined with each other that one has literally to hew one's way through the forest with axes. Nowhere have I seen vegetation so dense as that met with just below the Alpine zone. The ranges present a remarkably smooth and shorn appearance, and this is due to the dense compact mass of rhododendron jungle, every bush of which attains exactly the same height. No branch dares protude above his follows for fear of being cut off by the icy winds. One great drawback to the Sikkim range is the almost entire absence of the smooth, turfy downs met with in the western Himalayas, rhododendron of one kind or other occupying the entire zone in which vegetation is met with. The commonest bird Mr. Robert met with around Kinchinjinga was the Blood pheasant, which he found in the winter at about 13,000 feet in great packs. Munal are plentiful in parts at altitudes between 10,000 and 12,000 feet and the Snow pheasant also at higher elevations. These birds occupy the same zone in Sikkim that they do in other parts of the Himalayas.

In saying a few last words regarding the lofty Kinchinjinga it is necessary to state that the slope presents more naked spots than in the case of mountains in the western Himalayas of far less altitude. The snow fields are less continuous, and this to a certain extent detracts from the grandeur of its appearance. Its outline too is tame and almost ugly, but taken as a whole the vast pile is, with one exception, more worth seeing than any of the great peaks of the Himalayas. I would make Nanga Parbat, as seen from the north-west, that one exception, but unfortunately, besides Major Biddulph and myself, no one, as far as I am aware, has ever had the good luck to climb to the lofty crag whence the finest snow view on the globe may be obtained; hence the comparison I draw to the disadvantage of Kinchinjinga has little significance.

It is remarkable and perhaps to be wondered at that only one Englishman besides survey officers has had the curiosity to examine the topography of Kinchinjinga closely, and the praiseworthy efforts made by Mr. W. W. Graham to ascend to its highest peaks deserve to be rewarded with success. The Anglo-Indian sportsmen who have visited northern Sikkim are at the most only two or three in number, and this notwithstanding that the country is quite as accessible as any other part of the Himalayas. During the past six weeks I have been engaged on fixing Himalayan peaks and ranges from the tower stations of the Trigonometrical Survey in the plains of Bengal, and a few words regarding the results of my examination of the Everest group may not be out of place, though until further information is forthcoming a full report on the greatest of all mountains cannot be rendered. In the first place it should be understood that Mount Everest cannot be approached by an European

* I am informed by Dr. Scully that a very rare bear is found sometimes in North Sikkim.

within 80 miles, owing to the persistency with which the Nepalese Government keep Englishmen out of their country. The survey which is now being made of the Everest group is therefore conducted under the greatest disadvantages. Sir Joseph Hooker, when he was at Walloon and in that neighbourhood, was within 65 miles of the peak, but he was deep down in the valleys, and the view of Everest was blocked by the great peak No. XIII or Makalu. Probably Hooker never saw Everest. Sandakphu, 38 miles from Darjeeling on the Darjeeling and Nepal boundary, commands the finest view of Everest that is anywhere obtainable from British territory. The mountain from that place is 90 miles distant, and though so remote is a fairly striking object, and would appear to better advantage were it not that Makalu, which is 12 miles nearer, to some extent shuts out the view; and as the latter peak is exceedingly bold and picturesque in appearance, it generally comes in for more attention than its higher neighbour.

The outline of Everest is rather tame than otherwise; it is fairly sharp, and has a long snowy slope on its north-east flank, the south-east being precipitous. Peaks of 22,000 and thereabouts encircle its southern base, and below them are seen many outlines of dark mountain masses which are without snow. These middle distant ranges of the Eastern Himalayas are almost bold in appearance, but those within 20 miles of Sandakphu are tame and scarcely picturesque, and like all the Sub-Himalayas of Eastern Nepal, Sikkim, and Western Bhutan do not rise in artistic lines. As one proceeds north along the Sandakphu ridge, Everest gradually becomes hidden behind Makalu, and does not reappear until the foot of Kubroo is approached.

From due south, near the Koosee river in the Bhagulpur district, Everest is by no means a marked feature in the landscape; its southern face has but 190 feet of snow, below which the mountain falls for 4,000 to 5,000 feet in a series of crags of very dark-coloured rock, only here and there dashed and streaked with snow, below which are snow fields and broken masses of rock intermingled with snow and *névé*. When the atmosphere is not very transparent the sharp tip is seen as a mere floating white speck, the rock below it being almost exactly the colour of the sky and therefore invisible. The southern face of Everest from a near point of view is doubtless wild, and the cliff must be very lofty; but the great distance from which it is viewed renders this aspect of the mountain uninteresting. The crags, as also the summit, are strongly marked with lines of stratification which dip towards the west at an angle of between 20° and 30°. In fact, from the south, Everest has all the appearance of a very moderate hill, not in the least imposing and hardly picturesque. It is interesting only because by a trigonometrical operation its summit has been found to rise up further from the general level of the earth's surface than that of any other point. The finest mountains are those which expose the greatest extent of their slopes to view, and Everest, though 29,002 feet in altitude, only rises about 12,000 feet above its follows. It is absolutely lofty, but relatively only commonplace. Babu S. C. D., who has an extensive knowledge of Tibet, gained in several visits to that country, describes the mountain which the Tibetans suppose to be Everest as having "a rounded top." Now Everest is distinctly sharp at the top, and I therefore can only suppose that there is some other lofty mountain to the north or north-west of Everest which to the Tibetans does duty as the highest in their country. A new peak, T 45, fixed last month, has a rounded top: it is 27,000 feet high and situated to the north-west of Everest, and perhaps is the one alluded to by the Babu. The northern spur of the mountain was determined last year for a distance of 10 or 12 miles; it has peaks 23,500 feet or more, which rise but slightly above the general level of the spur on which they stand.

Where nearly everything is absolutely unknown, it is futile to discuss the probabilities of there being higher mountains than Everest or not. Native information on the subject of heights is quite untrustworthy, and as no European has been in a position to obtain any direct knowledge of the immense mass of snow mountains that exist between Everest and a point 80 miles to the westward, and again for 50 miles to the north, what man will be bold enough to hazard an opinion on the subject? It is true that Mr. Graham and his guide are reported to have seen two peaks to the north-west, higher than Everest, but how is it possible that they could have ascertained the fact? They did not know their own position, nor its height above the sea, nor, as far as I can see, did they know Everest by sight. Mr. Graham never arrived at any position whence Everest was visible until he found himself in the midst of lofty mountains at the base of Kinchinjinga. He did not go to Sandakphu to learn Everest and Makalu by heart, but he made his first acquaintance with the extensive panorama of the snows, which for convenience I call the Everest group, from a spot whence, Everest being unknown to him, he might well take, say, No. XIV for it, and mistake the real Everest and Makalu for the two peaks pointed out by the guide as being higher than it. From an extensive experience in Himalayan surveying, I can safely state that even when carrying on our work with the aid of the best maps, instruments, and requisite knowledge of surveying, we are liable, until we compute out the positions of our points, to mistake one mountain for another, even though we may have learnt their appearance by heart from other stations. But when without having the least acquaintance with the outline of Everest, or without knowing his position on the earth's surface, Mr. Graham suddenly emerges from a deep valley, and without further ado lays his finger on it, then I must say that I doubt the possibility of his being able to identify that particular peak. Two of my assistants last year mistook other mountains for Everest, and I myself recorded "Everest" against a mountain 5,000 feet lower than it. This was because I had not gradually worked my way up to the station of observation after having previously made the acquaintance of Everest, but I commenced work in a new part of the country

quite remote from the place whence I had seen it. I have the greatest respect for Mr. Graham's prowess as a mountaineer, and admiration for his most praiseworthy attempts to scale the highest peaks yet attained by man, but I wish most emphatically to deny his power to recognize peaks, the appearance of which was not known to him. The two peaks stated to have been seen by Mr. Graham and his guide must have been visible to them over the northern spur of Everest, which I elsewhere state to be 23,500 feet in altitude, and they must have been very far beyond this ridge, otherwise they would have been fixed by me during the operation which I am now conducting; and taking into consideration the curvature of the earth at very great distances, these peaks, if they exist, must be enormous indeed. Sir Joseph Hooker, whose scientific attainments and whose reputation as an exact observer of nature are beyond dispute, has given an opinion on the subject of estimating the height of snowy speaks by the eye alone which should be considered conclusive. So little did Sir Joseph trust to his own estimates of the height of the great peaks he saw far away in Tibet from the Donkia pass, that having observed the altitudes with a theodolite, he assumed different distances, and computed the different heights that those distances would give, but he never pretended to fix the peaks absolutely.

With the exception of the Kinchinjinga peak, No. XIII or Makalu (27,990 feet) is the finest yet fixed in the Eastern Himalayas. It stands apart from the Everest group, and exposes a great mass of snow towards the Sandakphu ridge. From the south, in the plains of Bhagulpur and Purnean it is the most striking object in the panorama of snow. It has a remarkable cup or hollow which extends for about one-third down its slope, by which it may be recognized. When examined with a high power telescope great masses of glacier ice may be seen finding their way over the edge of the cup. This ice has been collected round the sides of the amphitheatre-like hollow and deposited in the shape of avalanches to the bottom: thus it becomes what is called névé and afterwards is formed into glacier ice. The upper half of the mountain is composed of a very light-coloured rock, but the southern spur is dark like the cliffs which are seen on the southern face of Everest. The white colour of the rock lends it a softness, which is absent in the appearance of its higher neighbour. The southern and eastern faces are fully snow-clad, but on the west are much bare rock and extensive streaks and patches which are too steep to retain snow on their slopes. No northern spur of this mountain has been seen, but I have traced one of about 19,000 feet elevation towards the east, until it dips into the Arun valley. To the south two picturesque branches fully clad with snow are thrown off, but I cannot say that I have detected any saddle or ridge connecting Makalu with Everest.

From Sandakphu about 9,000 feet of this striking mountain are exposed to view, but except in the cup above noticed, there is no sign of a glacier. Makalu is remarkable for the very striking sharp-edged buttresses which are reared up against its huge sides, and which lower down become the starting points from which ranges are thrown off towards the east and south.

Now that our knowledge of the topography of the Himalayas is being extended, it is thought desirable to make a table showing a comparison of the absolute height of some peaks above sea-level, with the actual amount of their slopes exposed to view. Such a table for a few well-known mountains I here give, and a glance at it will show that the absolute height of the top above the sea is no criterion of the size of the mountain: I draw up this table partly with a view of bringing again more prominently into notice than I have hitherto done the vast superiority of Nanga Parbat in Kashmir over all other mountains at present known to us.

It is a veritable Deo Mir* or, as the Dard name signifies, "King of Mountains," and it cannot be too often or too highly extolled.

The top of Everest is 29,000 feet above sea-level, and at a distance of 90 miles presents approximately about 12,000 feet of its side to view. This, or a little more or less, is the actual height of Everest as a mountain, for practically we have no concern with the 17,000 feet which in reality form but a portion of the earth's crust. In other words, the general level of the earth's surface on which Mount Everest stands is at that particular place 17,000 feet above the average level, and the summit of the mountain above its base is but 12,000 feet.

Similarly, though the peak Makalu is elevated 27,990 feet above the sea-level, the actual mountain available for man to gaze at and admire embraces from top to base only 9,000 feet of vertical height, and is seen from Sandakphu, a distance of 78 miles. Kinchinjinga is situated 46 miles from Darjeeling, and though the top is 28,176 feet above sea-level, only 16,000 feet of its height is exposed. (The lower extremity of the slope in this case I take to be the valley below Jongri.)

Of Tirach Mirt in the Hindu Kush, near Chitral,‡ the base was only partially seen by myself, but Major Biddulph, who passed just below its south-eastern face, describes it as "occupying the entire view" at a distance of 40 miles. The peak is 25,400 feet above sea-level, and the base stands on ground which is 7,000 or 8,000 feet in altitude, thus leaving 17,000 or 18,000 feet exposed to view; and this portion which stands outside the earth is the real mountain, and it may be described as 17,000 or 18,000 feet high. In the latitude of Chitral the snow extends down thousands of feet lower than it does in

* Wrongly spelt on the engraved atlas sheet "Dinr Mur."

† The name is derived from Tirak, a poplar. These trees occur in great profusion on the lower slopes. Mir, mountain is pronounced Mir or Mēr, and occurs in Pá-Mir, Deo-Mir, &c.

‡ Derived from Chitr, cotton, and Al-Alia, country. Chitral isthe last place on the Kunar river where cotton is grown.

Nepal and Sikkim, and besides forms a thick unbroken covering without those blemishes and faults which so mar the appearance of the snow mountains in the Eastern Himalayas.

The mighty Rakaposhi or devil's tail of Gilgit, 25,550 feet, on ground which is seven or eight thousand feet above the sea, may be viewed from a distance of less than 40 miles by any one bold enough to make the journey over the dreadful Sai Char* pass to Chaprot, and thence up to the grass downs above that place, and the splendid appearance of Rakaposhi will be a sufficient reward for his trouble. It is a vast clean cut brilliant snow needle, absolutely sharp, rising thousands of feet above a mass of broken snows, below which are the wild precipices and serrated ridges peculiar to the Gilgit mountains. In the fore-ground are rolling grass downs, embellished with clumps of juniper; a deep valley lies at the foot, and on the west side rise black cliffs. Mount Blanc, though but 15,781 feet, rises from a valley of about 3,000 feet altitude, and therefore exposes 12,000 feet of its sides; but it must be mentioned that owing to the short distance from which the summit is viewed, the slope to a great extent is foreshortened, and much of the imposing effect of height is thereby lost.

Nanga Parbat's summit is 26,600 feet above the sea, and its base stands on the left side of the Indus valley, which at that point is but 3,500 feet; it therefore exposes 23,100 feet of its side to an observer, who, standing as near as he may dare to the edge of perhaps the most lofty cliff in the world with the Indus valley 12,000 feet below him, may regard at the distance of less than 40 miles the unparalleled view presented by the vast snow fields, glaciers, and crags of this king of mountains. It is a scene that is not grasped or taken in at once, but after a while the stupendous grandeur of the view is appreciated. It is quite overwhelming in its magnitude; it is in fact one of the grandest spectacles that nature offers to the gaze of man. Great height, vast breadth, and appalling depth are combined, and like the panorama of the Tibet snows, as described to me by Captain Harman, it is "immense." There is nothing small or mean about it; it is on a scale which is gigantic. Without considering the great slope from the level on which you are standing down to the Indus valley—a slope of about 12,000 feet—there still remains above the level of the spectator a mountain as big as the whole of Everest, and that, too, seen at less than half the distance.

Table showing the height of some mountains compared with the amount of their slopes which is exposed to view.

Rank.		Name of mountain.	Name and height of place of observation.	Distance from which observed.	Height above sea level.	Amount of slope exposed.	Angle contained in vertical view—degrees and quarter degrees.	Remarks.
Now claimed.	Accepted.			Miles.	Feet.	Feet.	Deg.	
	1	Mount Everest between Nepal and Tibet.	Dewangani, Purnea district, Bengal. 200 feet.	118	29,000	8,800 Approximate.	¼	A mass of dark crags and cliffs slightly streaked and dashed with snow. Capped with snow-point from 400 feet. Seldom visible to base on account of cloud and haze. Point of observation reached in a buggy or otherwise. Extensive panorama of surrounding snow peaks.
5	...	Ditto ...	Sandakphu, Darjeeling. 12,000 feet.	90	.....	12,600 Approximate.	1¼	A fine view. N.E. flank slope, well snow clad. South face broken and bold. Seen often in early morning; seldom in evening. Point of observation reached on hired pony. Great comfort, but cold.
6	2	K2 North or right bank of Indus on mountain boundary of Kashmir.	Range between Gilgit and Gor, 16,000 feet.	.....	28,278	.....	.....	For description and sketch see Drew's Kashmir. K2 is surrounded by a great mass of peaks which prevent much of it being seen. View not very impressive, but extremely wild.
7	3, 4	No. XIII or Makalu, between Nepal and Tibet.	Purnea district, Bengal, 200 feet.	120	27,800	5,600	¼	A fine bold mountain, well worth seeing; well snow clad. Outline very picturesque. Peculiar cup or amphitheatre at top, partly seen from Purnea district. Point of observation from comfortable tent. Requires clear weather, otherwise only tip is seen.
		XIII or Makalu ...	Sandakphu, Darjeeling, 12,000 feet.	76	.....	9,000	1	A magnificent mountain backed by Everest. Outline very bold. Fine view. Ride or walk to bungalow at Sandakphu. Made road.
1	5	Nanga Parbat or Dro Mir. Left bank of Indus, Kashmir.	Cliff above Gor overlooking right bank of Indus, Gilgit, 16,000 or 15,000 feet.	40	26,600	23,000	c. and more view with Eidolph.	The view—tremendous exposure of snow, cliff, and glacier—baffles description. Frightful journey over cliffs, rocks, torrents—cross the Indus, a turbulent rushing river, on raft. Cross snow passes. Tribes independent; not safe. Game. Flood. Landslip. Always snows, except for a short time in August.

* Sai, white; char, cliff.

Rank. Now claimed.	Rank. Accepted.	Name of mountain.	Name and height of place of observation.	Distance from which observed.	Height above sea level.	Amount of slope exposed.	Angle contained in vertical view—degrees and quarter degrees.	Remarks.
				Miles.	Feet.	Feet.	Deg.	
3	7	Tirach Mir, Hindu Kush, north of Chitral.	On road from Gilgit to Chitral, 8,000 feet.	40?	23,460	17,000 to 18,000	4½	A splendid mountain (see Biddulph's Tribes of the Hindu Kush). "Fills entire view." Dangerous journey. Passes rivers, cliffs, treacherous chiefs, uncertain tribes.
2	6	Rakaposhi, most westerly peak of the Himalayas, Gilgit.	Downs above Chaprot, Gilgit, 13,000 feet.	40 odless	25,500	12,000	4½ and more.	A superb snow needle which cleaves the sky. Most symmetrical shape; base wild and bold. Journey to Chaprot over awful pass of Shai Chár crossed by Biddulph and self. Tribes rather surly. Peak of view just off Biddulph's road to north of Chaprot.
4	3	Kinchinjinga, Sikkim.	Darjeeling. 7,400 feet.	46	28,160	16,000	3½ and more.	Magnificent view. Finest snow view accessible to ordinary traveller. Snow on slopes not quite sufficient. Much bare rock often visible; requires cloud at base to render view effective. Intermediate hills tame. Seen from "hotel door." From Sandakphu view very grand and imposing.
6	8	Mount Blanc, Europe.	Range above Chamumi, 7,000 feet.	Short distance.	15,781	11,500	.....	Tourist either rides, walks, or drives. A very fine view.

Survey of the Himalayan ranges.

While the triangulation of the higher snowy ranges has been going on, the importance of obtaining the topography of the lower hills has not been lost sight of, but it is to be regretted that the haze stratum which nearly always hangs about Bengal seldom sinks low enough to permit the sub-Himalayas to be seen. During the working season there have been but few days when the faintest outline even of the lower ranges could be detected. Nevertheless I have secured the Máhábárát range for 60 miles west of the point where Mr. Robert's sketch terminates. Mr. Barckley has also secured some topography, but not much. I think that there is little doubt that before the end of the hot weather we shall have mapped the whole of the ranges between the North-Western Provinces and Darjeeling. Máhábárát, I am told by a Nepalese officer, is the name of the whole sub-Himalayan range that extends from the Kosee on the east to the Gunduk on the west; it has the character of the Senchal and Kurseong hills, and varies from 8,000 to 6,000 feet. Near the left bank of the Kosee it dwindles down to 5,000 feet, but, as far as I have been able to ascertain from observations, never lower, except where there exist occasional gaps. This topography having been secured, I now have to dispose of the various branches of the Kosee river which wind about out of view behind the Máhábárát range, and this, I confess, I am at present unable to do.

Between us, Mr. Robert and I have dotted the country south of the snows with trigonometrical points, and I can find no room between any of them for a valley wide enough to contain the western Koosee in its course from west to east, that is from near Khatmandu hills on the west to Chatria thana. This is now the third season that operations have been going on facing the sub-Himalayas, but though Mr. Senior, in conjunction with myself in 1882-83, did a good deal in the Gunduck basin, and Mr. Robert in 1881-82 sketched a section of the Eastern Nepal hills, last year no topography whatever was obtained. It is work that requires an intelligent use of sharp eyesight combined with a fair knowledge of the simple rules of surveying. There is one way, and I think one way only, to secure distant topography. A plane-table survey, however rough, must be carried on *pari passu* with the theodolite survey, and after the computations have been concluded, the crude plane table survey must be adjusted to the trigonometrical points.

Demarcation and surveys on the Nepal-Bengal boundary.

This is an irksome piece of work which demanded close attention from Messrs. O'Sullivan and Barckley, who repaired the demarcations, and from Mr. Ryall, who carried out the surveys connected with those portions of the boundary which, owing to fluvial action, required rectification.

The ditch which runs along the greater part of the boundary between the Kosee and Biknatori has been cleared, and all the boundary pillars, with one exception, have been repaired. For the past season these operations cost Rs. 13,691.

We are now setting up iron posts on those sections of the boundary which have been rectified, and also the stone prisms which are to be laid down at the trijunctions of village boundaries that occur on the line.

All the pillars, prisms, and posts on the entire line have to be numbered afresh. This may appear to be a small and light operation, but to be done thoroughly and to avoid mistakes it will take two assistants several months to complete.

The survey of that portion of the Mechi river which forms the boundary between Nepal and British territory is in progress.

Extract from the Narrative Report of LIEUTENANT THE HON'BLE M. G. TALBOT, R.E., *Deputy Superintendent, Survey of India, in charge Baluchistan Topographical Survey, on Surveys in South-West Baluchistan;—season* 1883-84.

It having been arranged by the Surveyor-General that Lieutenant Wahab and I should accompany Sir R. Sandeman for survey purposes during his march through Western Baluchistan, we left Mussooree for Jacobabad early in October; a few days were spent there in preparations, and eventually we arrived at Quetta on October 17th. The party consisted of Lieutenant Wahab and myself, sub-surveyors Ikbaludin and Ata Mohamed, and 28 Punjabi klassies.

In concert with the Agent, Governor-General, Baluchistan, the following plan of operations was decided upon:—

Lieutenant Wahab and I were to march together to Kalat, and then separating, each of us was to carry on an independent series of triangulation in continuation of the Kalat series; Lieutenant Wahab working at first in a westerly, and then in a southerly direction, and I in a southerly, and then south-westerly direction; eventually we were to meet the Governor-General's Agent and his escort wherever he might appoint. To further this plan, Sir R. Sandeman kindly arranged with the General Commanding for an escort of 15 rank and file of the 2nd P. W. O. Grenadiers to accompany us.

We arrived at Kalat on the 30th of October, and were detained there some days taking in supplies, collecting camels, &c., and also on account of the weak state of the klassies, who were nearly all attacked with fever, brought on by the hot sun by day and the severe cold at night. Lieutenant Wahab also had a severe attack. The Assistant Surgeon at Kalat was very attentive, and did everything he could for us. On the 6th of November I started work, and by the 19th December, when the mission caught me up at Gidar, I had carried my triangulation and plane-table reconnaissance up the border of Azad Khan's territory, and intersected a considerable number of points to the south and west. From Gidar I had to keep pace with the mission on its road to Kharan, and further triangulation became impossible, so I had to leave it there to be eventually picked up on our return journey from Panjgur.

On the 23rd of December we debouched into the great Kharan plain, and were met by Lieutenant Wahab at Garok, one march from Kharan, where we arrived on the 24th. Lieutenant Wahab had brought down his triangulation close to Kharan in spite of great difficulties; he had also attempted and proved the impossibility of ascending the highest point of Raskoh. It was very fortunate he had done so, as otherwise we should have been tempted to have wasted our precious time at Kharan in the fruitless attempt. After consultation together we agreed that I should undertake the task of fixing points from an extension of Lieutenant Wahab's triangulation across the Kharan plain in the direction of Washuk, while Lieutenant Wahab should make his way across the Raskoh range, as far as time would allow, in the direction of Chagha.

After spending three days at Kharan, during which we twice observed at a station in the vicinity, and made a station in the camp, at which we observed a check azimuth, we obtained our camels, and leaving our escort of native infantry, started with some of Azad Khan's men as guides. I had also an influential jálawán named Abdul Karim, who was useful as interpreter, and in making arrangements with the natives. Alayar Khan, a brother of the Sárawán Sirdar, a most useful man, who had been attached to Lieutenant Wahab for his journey to Kharan, was allowed to remain with him by Sir R. Sandeman, and proved of great assistance throughout the expedition. At the first camp at Erikalag, just inside the Raskoh hills, we separated. Lieutenant Wahab continued his march to the north, while I, after observing at a hill in the vicinity of Erikalag, proceeded west along the foot of the wall-like southern ridge of the Raskoh range as far as Azad Khan's fortress of Jalawar. This place has been fully described by Lieutenant O'Donnell, who was my companion on this trip.

By means of stations near Kharan, Erikalag, and Jalawar, I was able to fix high points on the south of the Kharan desert, though by very long shots, some of the rays being as much as 80 or 90 miles; having thus made sure of having points with known latitudes and longitudes on which to tie my future work, I started south across the desert, and catching up Sir R. Sandeman at Mam, accompanied him to Washuk. On my arrival there, a day spent in reconnoitring showed me that I could fix three stations within easy reach of the camp, from which were visible the points that I had fixed from the Raskoh range. I at once commenced the triangulation, and on the arrival of Ikbaludin, who had been left behind to traverse the road from Kharan to Washuk, I measured a base of about a mile and-a-half, with a steel tape, observed an azimuth, and computed the positions of my stations. Lieutenant Wahab joined me in time to share in the azimuth observation and consequent computations. At Washuk I lost one or two days from the dusty haze which so frequently rises in Southern and Western Baluchistan, generally accompanying a southerly wind. While a few days previously I had been observing points 50 to 80 miles distant without any difficulty, at Washuk for two days I was unable to observe points five miles distant. After this the haze never really left us, sometimes for a day or two it was fairly clear, but we never had again such grand weather for observing as we had in November, December, and part of January, though even during that period the haze occasionally gave trouble for a day or two.

Sir R. Sandeman and escort marched from Washuk on the 10th of January, and having secured a satisfactory basis for the triangulation, the whole survey party started on the

14th. Lieutenant Wahab pushed on to catch Sir Robert at Panjgur before he left for Gwadur, plane-tabling the road as he went, and sending back traces to me to assist the triangulation. Ikbaludin continued his traverse to Panjgur, and I endeavoured to do the same with the triangulation.

On the 23rd I was joined by a party of the Sind Horse, which Sir Robert had sent out for my protection, he having heard of a party of marauding Damanis being in my neighbourhood. Fortunately they did not molest my camp, though traces of them were afterwards found close by.

On the 24th I arrived within one march of Panjgur, but such cold, violent, dust laden winds set in that observation was impossible, and I was glad to get a letter from Sir R. Sandeman on the 25th telling me that he would march on the 27th, and that he wished to see me before he started. Accordingly on the 26th I marched into Panjgur in a howling dust-storm.

Sir R. Sandeman arranged that a party of 15 rank and file of the 2nd P. W. O. Grenadiers should remain with us, that we should retain Alayar Khan and Abdul Karim, and further attached to us Mir Pasand Khan, son of Mir Murad Khan, the former owner of Kuhak, with two of Azad Khan's sowars, who were to remain with us as long as they were required. The only restrictions he imposed upon our movements were that we should not separate our camps, nor enter any territory whose ownership was under dispute.

Accordingly we abandoned all idea of carrying on two separate triangulations, and agreed that as I had begun the work, I should continue it, and that Lieutenant Wahab should undertake the plane-tabling. Ata Mahomed continued to record and compute, and Ikbaludin was employed in plane-tabling easy portions of the country. Four days were spent at Panjgur waiting for camels, during which time the weather changed and became provokingly clear. We utilized the time to a certain extent by taking some circummeridian observations for latitude, which was all we could do, as we had not been able to fix our position satisfactorily. On the 1st of February, after much wrangling with the camelmen, we started, carrying 20 days' rations, and retraced our steps towards Washuk to pick up the triangulation where I had left it. This was a work of some difficulty owing to the nature of the hills, which consist of numerous steep parallel ridges on which I found it very difficult to select points which commanded a view on both sides, and which I could make sure of recognizing from a distance. I had to make four stations without moving my camp more than three or four miles before I got the observations I required. Two of these stations have since been found unnecessary, and have not been included in the revised computations. We now left the Washuk road and turned north and west towards the Koh-i-Sabz, on which I made three more stations. While at one of these, the haze to the north partially lifted and gave me a glimpse of the western end of the Raskoh range, which enabled me, in conjunction with observations from other stations, to satisfactorily fix several points on it. As our orders prohibited us from crossing the Mashkel, and our rations were nearly expended, we turned south from the end of Koh-i-Sabz and returned to Panjgur along the Mashkel and Rakshan rivers, just in time to escape a downpour of rain. On arriving at Panjgur I found that Alayar Khan, who had been left there to make arrangements for food, had been so successful that I determined to make another circuit, this time to the south, and on the 20th of February we started again. At first I directed my attention to fixing as many points as possible up the Rakshan valley in the direction of my return route, so as to leave as little to be done there as possible, and for this purpose made two more stations on the north of the valley before commencing on the south. Eventually we crossed the Lagar Koh by a little used pass into the head of the Gwargu valley, and ascended two points south of that valley from which we had hoped to have done much. Unluckily the haze had thickened so, that, though I was able to fix some points on the range north of Kolwah Kej or Kech, the topographical detail was so blurred as to be almost impossible to sketch. I wished to make a third and, if possible, a fourth station on this range as far as time would allow me to go, and after three days' march, reached one of my intersected points which seemed promising. Unfortunately the day I visited it was even more hazy than usual, which again interfered with the plane-tabling, and to a less extent with the triangulation also. The weather looked so unpromising that we decided it was useless to wait to observe again from this station, or to make another further on, and returned to Panjgur again just in time to escape rain. Circumstances combined to delay our start, fresh camels had to be engaged, 30 days' rations had to be taken in, as we could expect none for the next 150 miles; and as I wished to observe an azimuth, I had to wait till the weather allowed me to do so. On the 14th of March the sky at last cleared, we got observations for azimuth from a station close to our camp, and the next day we started on our return journey. Our road lay up the Rakshan valley, on either side was a range of broken hills, so far apart that it was impossible to get from a station on one range to a station on the other, under two days. The total distance of the gap between the Panjgur triangulation and my Gidar triangulation was 130 miles, which had to be bridged before the rations we took in Panjgur were expended.

Though the actual series was not very much impeded by it, the haze continued to give trouble, particularly to the south and east, where we obtained far less, both of triangulation and topographical detail than we had expected. On the 26th of March from Dranjak H. S. I sighted some of the stations I had visited in December, and found from my plane table that there could be no very large discrepancy. A few days later, after visiting one of the

points that had been intersected both from Kharan and Gidar, I found that this discrepancy amounted to 7″ and 5″ in latitude and longitude respectively, much of which I am glad to say has disappeared on recomputation. After effecting a good junction between the Panjgur and Gidar triangulations, we reached the tract previously reconnoitred by me, and closing work set out for Quetta as fast as we could.

On the 29th of April we reached Jacobabad, where I found the office of the party, and assumed charge. After a few days spent in final arrangements, we started for recess quarters at Mussooree, where we arrived on the 6th of May.

The country visited presents many advantages for rapid work. The hills run in straight or gently curving ridges, the tops of which present numerous well marked points, so sharp that the difficulty sometimes was to put the theodolite upon them. The country is, as a rule, easily traversable by camels, so that the surveyor can generally get his camp within three or four miles of the point from which he wishes to observe, and the absence of any marked features over much of the plain country enables a large area to be rapidly surveyed. Great clearness of atmosphere occurs at uncertain times; but this which is so favourable for observation is always liable to be replaced by a dense haze which may last for several days; and at this season there is almost always a strong wind blowing, sometimes rendering it impossible to observe, and on at least half the days I had to dispense with an umbrella. Though one can generally get one's camp within a reasonable distance of the point one wishes to observe from, it is quite uncertain whether water will be found there, and in some parts, notably the Koh-i-Sabz, water, where found, will very probably be so salt as not to be drinkable.

The hills are made up of masses of minute features, in many cases so small as to be incapable of delineation on the ½-inch scale, and yet so tangled and mixed that it is difficult to grasp their shape sufficiently to generalize them. Though we met with much bad weather, it fortunately did not come at the times at which it would have been most inconvenient, and the rain which fell while we were at Panjgur relieved us from much anxiety about water in that neighbourhood.

The success of the survey is in a great measure due to the excellence of the arrangements made for the party by Sir. R. Sandeman, who with unvarying kindness rendered it every assistance throughout the expedition.

Extract from a report by Major T. H. Holdich, R.E., *Deputy Superintendent, Survey of India, on an expedition to the Takht-i-Suliman in December* 1883.

The object of this survey expedition was to explore the Takht-i-Suliman mountain and complete as much of the topography as possible of the Sherani country, keeping up a continuous border survey with that already completed to the north, which terminated about the line of the Gomul valley; and to fix, if possible, a certain number of points in the country west of the Takht-i-Suliman from trigonometrical stations on the mountain itself.

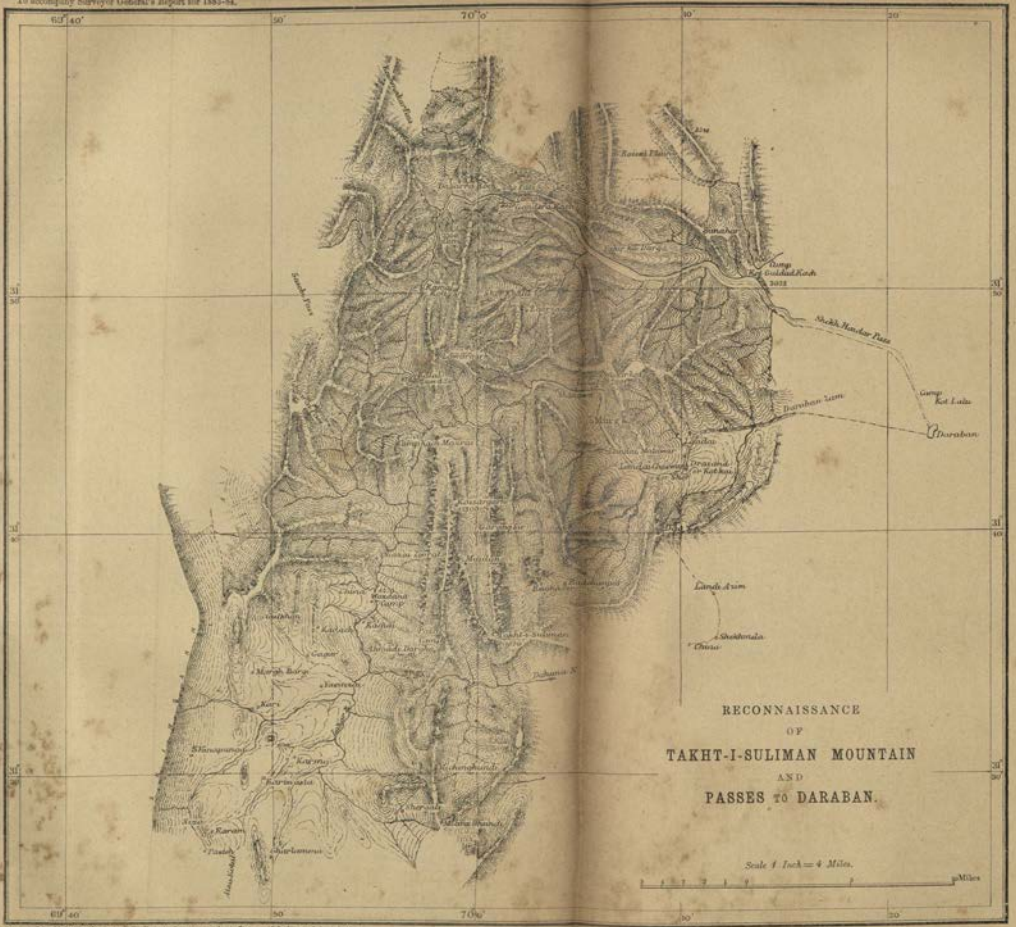
For the completion of the topography, Mr. Coxen and sub-surveyors Imam Bux and Hera Singh were provided with projected sheets on ½-inch and ¼-inch scales for plane-tabling; Hera Sing's duties in the first instance being confined to traversing.

Triangulation.

For the triangulation, I and sub-surveyor Esuf Sharif were each equipped with a 6-inch subtense theodolite, a 12-inch heliotrope, and one or two smaller heliotropes, which proved useless in the peculiar state of the atmosphere.

Only one Great Trigonometrical hill station was available for possible reference from any position so far west of the frontier as the Takht mountain. It was obvious from the very commencement of survey operations that no station of the Indus Series, in the plains, would ever be visible from the Takht on account of the dense atmosphere overlying the banks of the Indus. It was possible that the one hill station referred to, Shekh Budin, might be visible, as its height was considerable; it was an unmistakeable and conspicuous hill, and one of the 12-inch heliotropes could be placed on it. On examination it was found that neither of the original sites of the Great Trigonometrical stations on that hill could be identified, but this was of no great consequence, as an excellent site was afforded by the roof of the highest building in the place, and the principal stations of the Indus Valley Series, from which the Shekh Budin points were originally fixed, were all found to be in perfect order, so that the new hill station was easily fixed by subsequent triangulation. There was no possible means of carrying any connected series of triangles from the frontier up to the mountain, and at best it was exceedingly doubtful whether such a series would result in fixing any points on the main ridge better than the two already fixed by means of first class instruments from the Indus Series, called respectively the northern and the southern summits. The great trigonometrical computations showed discrepancies on the common sides to these two points of a few feet only: they were the two obvious points (so far as could be seen from the eastern side) to be selected, as giving the best base for triangulating to the west of the Takht; and any third point would have been quite out of place and useless on account of the excessive shortness of the base. These two points included apparently the full length of the mountain, which was, however, something less than eight miles. But as it was hoped that in the course of the circuitous march to the Takht mountain some third point to the north might be

To accompany Surveyor General's Report for 1883-84.



Lithographed at the Survey of India Offices, Calcutta, January 1884.

reached which would give a check value on the observations from the other two, the following arrangement was made for fixing any such position :—

Esuf Sharif was placed in the Shekh Budin station with orders to reply instantly to any signal made from the hills, and to show a steady light in reply. He was then to observe the angle between the signal given him and one of the principal Great Trigonometrical stations in the plains, carefully noting the position of the point observed, and subsequently observing that same point from the principal Great Trigonometrical station below: thus two angles would be secured from an assured base; the third angle, viz. that between Shekh Budin and the Indus valley station, it was known would be impossible for observation, owing to the haze already referred to. It must be understood that while it is possible to observe from the plains to the hills under such conditions, it may be totally impossible to observe from the hills to the plains. It may be as well to state at once what measure of success attended these arrangements.

Under considerable difficulties, as will be hereafter detailed, the third point north of the mountain was reached sufficiently early in the day for Shekh Budin to be visible. After some delay an answering light was obtained from Esuf Sharif on that station; but this would have been impossible with any glass of a less dimension than 12-inch. There was no difficulty in observing to Shekh Budin, but there appears to have been great difficulty in observing from it. Anyhow, Esuf Sharif reports that he was quite unable to discern the signal after the first flash, nor was it of any consequence, for he could not again have identified the position of the point reached, owing to its not appearing to him on the sky line. Another and slightly higher range was at the back of it, the effect of which was to obscure the position of our point more effectually. This higher range was beyond our reach. Consequently the position of this station, Kārajbina, depends entirely on an interpolated value from the Great Trigonometrical intersected points surrounding it. These are of very unequal value, but still should give fairly trustworthy results.

The second point reached, viz. the northern summit or "Kaisargash," proved to be a well fixed and thoroughly good position, but the difficulty of reaching it, owing to its altitude reduced the time for observing to very narrow limits.

The southern summit, which it was intended to visit, proved a complete failure. From below, eastward, it appeared a sufficiently well defined point, but it proved to be a square-headed block of sandstone, level at top, apparently inaccessible on all sides, and covering so many acres in extent that the coincidence of common sides was evidently a happy accident. Moreover, it was on the eastern ridge of the mountain, overlooking the plains of India and much shut out from the plains of Afghanistan by the western ridge. The choice of a second station on the mountain was thus rendered exceedingly difficult. The western ridge afforded the only site for a station from which the Afghan plains were sufficiently visible, but from no point on the western ridge was the northern summit, being on the continuation of the same ridge, visible, nor from it, again, could the plains of India, or Shekh Budin, be seen. There was nothing for it but to fix another station by interpolation, but in this case the surrounding points proved exceedingly weak, the nearest being the vague and uncertain "southern summit" referred to. But for the future chance of fixing that station from the Zhob valley, it would have hardly been worth the day's observations. That chance has come more speedily than could have been anticipated, and if the position of it can now be but approximately defined, there should be little difficulty in identifying and fixing it permanently.

On the 17th of November the force was camped near Daraban, facing the Takht-i-Suliman, and not more than 20 miles from it in a direct line. The summit of the mountain was then covered with recently fallen snow, which threatened to retard the progress of the party. Early on the morning of the 18th, the first camp over the border in the Shekh Haidar pass was reached, and during that day plane-tabling was commenced by Mr. Coxen and the Bozdar, from the neighbouring heights. The character of the ground bordering the pass was distinctly visible all the way to the northern foot of the mountain. This strip of country, 20 miles wide, between the foot of the eastern slopes and the frontier, was made up of low sandstone ranges of most irregular formation and intricate topography. Immediately on the frontier line were fairly well marked, definite ridges, but from the frontier to the first line of the sharp edged knife-like limestone ridges, offshoots of the great mountain itself, and parallel to its formation, were nothing but barren, broken, sandstone hills of no great altitude, bare of cultivation. So far as could be seen, though here and there hidden in the recesses of the watercourses, were small insignificant villages, each with its little patch of unhealthy-looking fields. The line of march followed the Zao stream, usually called the Shekh Haidar pass, to a point called Gander Kach, where the real defile of the Zao, about four miles in length, commences at the end of the second day's journey. So far the Great Trigonometrical points fixed on the line of the Suliman ridge, supplemented by fixings obtained from points visited on the frontier line previous to the first day's march, were sufficient for the plane-tablers to carry on the topography of a strip of country of varying width, adjoining the route itself. The route was traversed at the same time, chain measurements being taken and bearings recorded with a prismatic compass. From Gander Kach through this four-mile defile, the traverse alone could be depended on. It was not till the party emerged on the far side that plane-tabling points were again visible. Each day a small guard, usually not more than a havildar's party, was detailed for duty with the signallers and surveyors, who ascended the highest available points on either side of the route, whilst the main force of about 2,500 men was retained in as compact a formation as possible on the bed of the pass. The defile was not found easily passable. In addition to waterfalls and other obstructions, there was the well-known Dobarra rock, which

blocked the way so as to narrow the pass to a few feet, through which only unladen baggage animals could make their way. In the absence of pioneers or sappers, or any scientific road-making equipment, this was a serious obstacle, and it was only finally surmounted after two days delay by passing the 1,000 Povindah camels (of which 500 were laden with "bhoosa" for the use of the 800 mules) through first, while the force remained encamped at Gander Kach, in rear of the Dobarra stone. During this process but little could be done in the way of surveying, but the Bozdar made a useful reconnaissance towards Drazand, and the traverse was kept up continuously. From a little ahead of the Dobarra rock a long march was made to a place called the "Ghât," passing over the kotal or watershed at the head of the Zao, and down into the drainage of the Duraban Zam, which at the Ghât rushes through a wild narrow gorge, cutting across the massive limestone ridges of the northern spurs of the Takht-i-Suliman and streams out into the sandstone country beyond. This forms the Daraban pass. It is possible for men on foot to get through it, as later on Hera Sing carried a traverse from the site of this camp through the pass, fixing the position of Drazand, and finally joining on to the line of original route. On the day on which this march was accomplished, an effort was made to reach the high range which is the natural continuation of the Takht ridge, northwards, and there to establish a trigonometrical station which might serve as a third point of observation to the two on the Takht mountain itself. Starting at day-break with a small escort of 25 men, the party struck into a line of drainage which obviously would finally carry it to the summit of that ridge if persistently followed out. No guides were procurable, and it consequently devolved on the survey officers to find their own way about. The ascent lasted many hours, and was very severe. In the short November days it was soon apparent that the real backbone of this great range was beyond reach, and that some minor point must be selected in order to secure time for even a rapid round of observations, in addition to the plane-tabling. The point called "Karajbina" was finally selected, and from it communication by signalling was opened with Shekh Budin. Late in the afternoon the observations were concluded, and it was dark before the party had reached the Zao nullah, on the line passed over by the force. The greater part of that long march to the Ghât had to be made at night by the survey party and the small escort with it, but no attack was made and camp was safely reached. I was, however, warned by General Kennedy, commanding the force, that no further attempt to reach points so far from the line of route would be permitted. From the Ghât to Wazdana and Wazdana to Pazai the topography was carried on as before with the aid of the Takht points, and one or two north and south of the mountain. At Pazai the force faced the western side of the mountain, nearly opposite the Southern Takht peak, and a small narrow path up a steep spur leading to a defile through the stupendous cliffs which surrounded its summit showed the way to the top of the mountain. Such a pathway would have been difficult enough at any time, but it was now held by the Kedarzai section of the Sherani tribe, who had built formidable "sangas" and other barriers across the defile, and were prepared to defend it to the last extremity. A survey reconnaissance, however, assisted by the local knowledge of the Bozdar, led to the suggestion that another way up might be found by making a long flanking movement to the southern end of the mountain, following the course of a nullah, the head of which must clearly be found under the edge of some rather more accessible looking, but still precipitous, cliffs that could be seen through the telescope in that direction. But as such a movement would have no chance of success unless by way of a surprise, and as Sherani guides were certainly not to be depended on, it devolved on the survey officers to show the way in the dark. Accordingly, with the help of the trusty old Bozdar, I offered to guide a flanking party to the summit of the mountain by night, and to turn out the Kedarzais, if possible, by daybreak. It was a long and anxious night's work, stumbling almost blindly along the bed of a nullah full of boulders and fallen trees, and as day dawned we just found ourselves on the summit without having fired a shot, but still a long distance away from the head of the Pazai Kotal. It was then difficult to determine what course to pursue. There were two ways leading to the Kedarzai position: one along the edge of the cliffs, which might easily prove impracticable, and another which was an obvious hill track, and which the Bozdar rightly surmised led from their position to the Kedarzai village in the plains below. We followed both, the main body of the force took the road, and a smaller party of the 1st Sikhs, which I accompanied, pushed their way along the cliffs. The latter were the first to reach the Kedarzai position, coming suddenly to a point commanding it, just as the front attack from below was beginning to develop. It needed but one volley from the advanced guard of the Sikhs (about fifty men) to scatter the whole Kedarzai force. They were so completely surprised, and so utterly routed, that I believe that in the course of an hour or two not one was left on the summit of the mountain. Their loss was about 30 killed and ours was *nil*.

The summit of the Takht mountain was found to consist of a long, narrow valley, about eight miles long, and of width varying from one to two miles, enclosed between parallel ridges of rugged and precipitous limestone rock, seamed and scarred with deep indentations where the drainage had worked its way during the course of ages to the plains below. About two miles from the highest peak, the northern summit, called locally the "Abashta chuka," or juniper point, or sometimes the "Kaisarghar," was a level space, covering about half a square mile, called Maidan; this was the water parting. From here the drainage found its way through precipitous gorges both to north and south along the line of the enclosed valley. The whole mountain was thickly covered with two classes of pine; the "chilgosa" (or edible pine) and the *pinus excelsa*. During the first day, after securing the road up the

mountain, a reconnaissance was made northwards along the valley in search of water. No water was found, although it probably existed far down in the deep ravines which drain this central valley. At Maidan there were two dry tanks, said to be full of water immediately after the rainy season, and generally to hold a sufficient supply all through the subsequent winter. The want of water seriously retarded the progress of the work. Not less than 450 men were considered sufficient as a guard and escort to the survey party, and 150 more were added to assist in transport arrangements. Water was brought up from Pazai in pukhals, on mules. On the 29th November the advanced force pushed on over most trying ground to Maidan, and the night was passed there round log fires, which were freely kindled in order to temper the cold of 18 degrees of frost. On the 30th the great "Kaisarghar," the highest peak of the Takht, was ascended. The air was clear, and a most comprehensive view northward and westward was obtained. Unfortunately the delay caused by taking 450 men up a steep and rugged mountain peak was fatal to the chance of a long day's work. Two or three hours were all that were obtainable, and, unfortunately, also at this juncture the Bozdar collapsed with pleurisy. Mr. Coxen never attempted the ascent, so that triangulation and topography had thus to be carried out together by one unassisted officer. The extent of view was very remarkable towards the north-west and south, but eastward the eastern ridge of the mountain blocked out the view of the plains. The height of the "Kaisarghar" (11,300 feet above sea) was such that the innumerable lines of hills traversing the central Afghan plateau were very much dwarfed to the observer, there being absolutely no peaks or points in that direction which appeared to have any special prominence. A reference to the plane-table chart very soon showed that every commanding peak that in any way stood out in the perspective of this vast landscape had already been fixed in the course of the Afghan surveys. This was satisfactory to a certain extent, but it still left a large central area unprovided with trigonometrical points. Observations were accordingly taken to these low lines of hills, and a record kept of the approximate distance and appearance of each point observed; but it was exceedingly difficult to pick out any point certain of identification in future, and the intense cold rendered the process of observing a most trying operation. It was almost more important to examine the topography of the map compiled from recent explorations than to take observations with the theodolite, and this part of the work proved entirely satisfactory. The distance was too great generally to make certain of details, but many important geographical features in the Birmal hills, the Gomul and Zhob valleys, and the Musakhel country of the Upper Vihowa, recently explored by the Hakim and the Bozdar, were easily identified, and the general correctness of their geography certified. It may be stated broadly that the trigonometrical fixings required as a basis for topography in that central area, which is bounded on all sides by completed surveys, are very few. The summit of nearly every hill in that area would have sufficient command to bring well fixed points into view along three-fourths of the horizon; but, as matters now stand, the scale would be small to admit of their introduction into the map. It is certainly advisable to obtain more points if possible, and the triangulation from the Takht will secure this result. On the night of the 30th, another bivouac was made on the Maidan, and the following day the party returned to the Pazai pass. No attempt was made to ascend the southern peak of the Takht for reasons already given, but an exploring party would doubtless have visited that corner of the mountain, to ascertain the accessibility of the peak, and to visit the great shrine which exists below it (and not, as is generally supposed on the summit), but for the impossibility of providing for such an unwieldy force as was considered necessary for escort duty. Another and more suitable peak to the south-west of the Southern Takht was selected for a station, and observations, combined with topography, were taken on the 31st. Here the luck which had so far attended the operations in the matter of fairly clear weather suddenly failed. The day was cloudy and hazy, but so far as it was possible to tell, no point previously observed was missed from the round of observations. The return journey to Dera Ismail Khan was unmarked by any special incident. Fresh points of vantage were reached by the topographers, Mr. Coxen having penetrated some distance into the hills west of the Takht during the course of the operations on the summit of the mountain. The topography was increased and improved, especially by the plucky traverse run by Hera Sing, who took a native escort only, and traversed the "Ghat" defile to Drazand. This left very little of the district between the Takht and the frontier unmapped. Subsequent to the return to Dera Ismail Khan, the Bozdar continued the topography of this trans-frontier strip southwards, but was unable to map the Dabua pass, which still remains a blank. Esaf Sharif's survey of the Gomul pass connects the work with Waziristan on the north, and a subsequent exploration on his part up the Reminuk pass to the foot of the great Misri Rob mountain has filled in still further details in continuation of the Bozdar's topography. Thus, with the exception of the head of the Dabua pass, the topography of the frontier is continuous and complete from Kohat to the Reminuk.

Memorandum on the tribal divisions of the Kakar tribes by Mr. G. B. Scott, *Surveyor, Survey of India, dated 28th November* 1884.

Tribal Divisions and Locations.

The *Kakars* are divided into two main branches, known respectively as the *Sanatia* and *Sanzár*. The latter appears to be that hitherto styled the *Saran Kakars*. To the name

Saran I could find no other clue than one given by the chiefs assembled at Mena, that it was applied to the Sanzar by those unacquainted with the true appellation.

The *Sanatia* occupy the country between the Harnai and Bori valleys, portions of the *Pishin* and some villages at the extreme head of the Bori.

The sections and sub-sections of the *Sanzár* are given below:—

The Sanzár are divided into six main sections: 1, Alikhel; 2, Arabikhel; 3, Utmankhel; 4, Barátkhel; 5, Abdullazai; 6, Kibzai.

1. The *Alikhel* occupy large portions of the main Zhob valley and Khaisor.
2. „ *Arabikhel* occupy the eastern portion of the Bori (or Árabori) valley.
3. „ *Utmankhel*, most of the western portion of Bori.
4. „ *Barátkhel*, the country in the neighbourhood of *Chena* between Marra and Zhob.
5. „ *Abdullazai*, Mena Bazar, and country to the north and east of it.
6. „ *Kibzai*, or *Kiwaizai*, Morga, Kakhoo, and neighbourhood, up to the Musakhel country.

These are sub-divided as follows:—

The Alikhel.

1.	Shadozai ...	*a.*	Shamozai ...	Mardanzai	...	Watral and Khaisor
				Ialalzai	...	Zhob and Khaisor.
				Massazai	...	Zhob and Arat-i-khula.
				Aladadzai	...	Zhob and Khaisor.
		b.	Ibrahinozai	Khoidadzai	...	Hindu Bagh and north of it.
				Daulatzai	...	Sur Tangi, Tirakhula, and Zhob.
				Akhtarzai	...	Zhob (Shinkai Bagh, &c.)
				Shahzai	...	Among the others in Zhob.
				Marozai	...	
				Ahzai	...	
2.	Mirzai ...		.....	Patozai	...	Kazhe and Sharan.
				Fakirzai	...	Ditto.
				Washinzai	...	Gwandamarra.
				Ahmakzai	...	Kats (in Bori).
3.	Badsuzai ...	*a.*	Yahyezai ...	Ismailzai	...	Zhob, Wakhlin, and Eastern Khaisor.
	Also known as			Manakzai	...	
	Dreplarai or	*b.*	Alizai ...	Adinzai	...	
	3 fathers.			Baizai	...	
				Anezai	...	
				Ibrahimzai	...	
4.	Gorizai ...		.....	.....		Thahigalu.
5.	Ismailzai ...		.....	.....		Gwal and neighbourhood.
6.	Hedarzai ...		.....	.....		

The Arabikhel in Bori.

LOCATIONS.

1.	Hamyazai ...	Mekhtar, Nalai, Nushpa, Wahar, Eastern Sharan, Nai Wiala, Sabara.
2.	Alizai	Western Sharan. Chena, Sagrai, Barnamai, Sharan.
3.	Shabozai ...	Dargai (Eastern).
4.	Khudizai ...	Dilhi, Lahor, Marra, Wariagai, Dargai, Zangiwal.
	Khanan or ruling section.	Eastern Karez, Eastern Shah Karez, Pinkai (on Toralar). All four sections graze their flocks on Torkheza, Churma, and Uzhda.

The Utmankhel.

a.	Shahbazai ...	Pathan, Sirki Zangal, Kohar.
b.	Mahmudzai ...	Kot and neighbourhood.
c.	Nakozai ...	Rodlin, Arboshin, Nigange (Nimgan of old maps).
d.	Turkzai ...	Zgarluna, Western Karez, Western Shah Karez, Jarkarez, Kohar, Sirki Zangal.
e.	Khadarzai ...	Minara, Agberga,

A family of Syuds known as *Baidar* live in Jarkarez.

The Barátkhel.

This class is not divided into any well-known sections; is not so considerable as the others; lives in Chena and neighbouring hills between Bori and Zhob.

The Abdullazai.

a.	Pakhezai	...	... Mena Bazar.
b.	Mallizai	...	... In hills north and east of Mena, as far as Marani and Mandokhel country.
c.	Badenzai	...	...
d.	Khajalkhel	...	... Pagaosheks, a valley near Sawara, south of Mena.

The Kibzai.

a.	Kabalzai	...	... Morga Kakshai.
b.	Shamamzai	...	... Kakhas, Barakwal.
c.	Khudizai	...	... Taoda and neighbourhood.

The hamlets of Chimjan, Chinalai, and Dargai on the west end of Bori, and certain hamlets among the other Bori villages are inhabited by *Dumers*, a tribe apparently descended from the retainers of the first Kakar invaders, and known as "Hamsayas." They also occupy villages in the *Sanatia* country, among others, *Baghao*, *Sinjawi*, and *Smallen* on the Quettah-Duki road. They appear to be more skilled and careful in agriculture than the Kakars.

The Musakhel Tribe.

The Musakhel, which is quite distinct from the Kakar tribe, inhabits the country along the upper portion of the Suni and Vihowa rivers, between the eastern watershed of the Bori, the Bozdar and the Sharani countries. The people are nomadic in their habits and possess large flocks and herds; but their chief wealth consists of camels, and they are largely engaged in the carrying trade between Zhob, the Bori and India, especially the Lehrzai section, which does not appear to have any settled habitation. They probably would find it difficult to muster 1,000 *talwars*, all told, or 100 matchlocks.

The Musakhel.

1.	Lehrzai	...	Mangazai	... Bazar, Kot, and scattered over the hills in blanket tents.
			Kabalzai	...
			Nohzai	...
2.	Hassankhel	...	Senzai	... Toi.
			Umarzai	... Premzai.
3.	Bolkhel	...	Hamzazai	... Baha.
			Mugdzai	...
			Malizai	... Choha.
			Shadizai	... North of Nari.

Estimate of the fighting strength of Sanzár.

The care and persistency with which the Zhobwals and others hid themselves and their families, the peculiarly low hovels in which all but the chiefs live, only showing as low mounds of earth, and the numbers who live a purely nomad life in blanket encampments, render it difficult to form a correct estimate of the inhabitants. But the following process may give a fair approximation.

The Boriwal, consisting of two main sections of Sanzár,' viz. the *Arabikhel* and *Utmankhel*, live in fairly well-built huts in villages that form a marked and pleasing feature in Bori, in contrast to Zhob. At first sight these villages appear very large, but on closer inspection it is found that large portions of what appear to be habitations are enclosed fruit or vegetable gardens.

They engage more largely in agriculture, possess a far larger area of cultivation, are evidently much wealthier, except in sheep and cattle, than the Zhobwal, and clan for clan should certainly be more numerous.

They occupy about 35 villages from Mekhtar to Kats; allowing 30 families for each village, or rather cluster of enclosures, and two able-bodied men for each family, we get a total of 2,100 *talwars*; add ⅓ more for the nomads, and we get a sum total of 2,800 fighting men, or 1,400 for each section.

Taking, next, the most powerful of the Zhobwal, the *Alikhel* section, we find them divided into six sub-sections, three important, three unimportant. Of the three first, taking the most powerful, the *Shadozai*, we have the occupants of Hindu Bagh of some 200 to 300 hovels in the neighbourhood of Shah Ishan Killa, and the Daulatzai hamlet perhaps capable of sheltering 200 families, thus we get a total of about 700 families: again, allowing two able-bodied men for each family, we get 1,400 men; add about a third for pure nomads, and we attain a total of 1,800.

Taking, next, the *Badsuzai* section, the group of huts they occupy in Zhob might shelter 300 families at the utmost; add 100 more for nomads in Khaisor and Wakhlin, and two able men for each family gives 800 men. Allowing an equal number, that is 800 men for the *Mirzai* and half that number for each of the three less powerful sections, viz. the *Ismailzai*, *Hidarzai*, and *Gorizai*, we get a total strength for the *Alikhel* of 4,600 men, which is evidently rather over than under the mark as compared with Bori.

Next, allowing something less than to the two Boriwal sections for the *Abdullazai* and Kibzai, or say 1,200 men each, and say 1,000 for the smallest section, the *Barátkel*, we then have the following numbers :—

1.	Alikhel	...	...	4,600	*talwars.*
2.	Arabikhel	...	...	1,400	,,
3.	Utmankhel	...	...	1,400	,,
4.	Barátkhel	...	...	1,000	,,
5.	Abdullazai	...	...	1,200	,,
6.	Kibzai	...	...	1,200	,,
			Total	10,800	able men.

Of these, at least one-third would be compelled to guard the flocks, herds, and families in a tribal gathering.

I find the total number of *men* has lately been estimated at about 144,500. Even allowing men here to mean *souls*, it would still mean a fighting strength of 29,000 men. But the *Sanatia* are only estimated at 7,000 men. As these are descended from the same stock, occupy an equal, if not larger, extent of country, are more settled, and possess more villages, and have always held their own against the Sanzár, the total strength should be quite equal to, or very near, that of the Sanzár : I consider 10,000 *talwars* a very liberal allowance for the Sanzár Kakars. Certainly this number only allows about 40 souls per square mile. But a large portion of the country is uninhabitable, and a larger still, only suitable for grazing purposes.

The principal articles of import are—

English and Indian cotton goods, indigo, salt, iron, copper and brass utensils, wooden platters, sugar, molasses, tea, alum, leather, shoes, China-ware, and cattle.

Exchange is generally by barter, but British Indian coinage is coming into general use. The terms pisa, anna, and rupee are adhered to : a 4-anna piece is called a "pao," and and an eight-anna piece a "habasi."

The following local names of trees found in the Zhob hills may be useful :—

Tamarisk	*Shinezgai.*
Wild olive	*Sharawan.*
Juniper	*Obushta.*
Poplar	*Spinawani.*
Willow	*Willi.*
Pistachio, a small wild variety	*Uzhgai and Shna.*
Bhan (Punjabi)	*Palawan.*

I have here only taken up topics unlikely to be taken up by those unacquainted with the language, and only that portion of Zhob, &c., that I was more particularly employed in.

Notes by Col. H. C. B. Tanner, s.c., *Deputy Superintendent, Survey of India, on the journey of the Lama through Central and Southern Tibet*

Amongst other information of great interest brought back from Tibet by the Lama is his account of the famous lake of Yámdok-tso or Lake Pálti. The notes are accompanied by an excellent map obtained by pacing and angular measurements made with a prismatic compass. The Lama made a circuit of the whole lake, and then a circuit of the tract which is almost enclosed by arms or broad creeks in which the western extremity of the lake terminates.

Yám or Yeum of some. Nagarchi.

All previous travellers and explorers have confined their examination of the Yámdok-tso to a small section of its north-western shore between Nágartsi and the Khámba La pass, because that section lies on the high road between Shigatsi and Lhása. Mr. Thomas Manning in 1811 followed this route when he visited Lhása ; and the beautiful view he obtained as he approached the lake from the west is one of the few in all Tibet that called forth remarks of admiration from him. Beautiful as the view of the long reach of the northern creek appeared to Manning, it cannot be compared with others that may be obtained from the southern or eastern shores. Manning's view was restricted to one arm of the lake, only about 1½ miles broad, and extending for about 16 miles, and the snow-capped mountains which were visible on the opposite shore were too close to allow of an effective view ; but from the points towards the eastern shore the snow-clad mountains, distant from 16 to 25 miles, are likely to appear to great advantage, reflected in the lake. From the south the view across the water is varied by an additional point of interest in the shape of an island and monastery, about a mile or less from the shore. The whole lake is embosomed by mountains, except at the eastern extremity, where they fall away and admit the respectable stream which drains the Yámdok kár má sing or the "starry plains" or "plains of heaven," a delightful and far-reaching extent of rich sward

Sheet No. 6 of NORTH EASTERN FRONTIER

TRIGONOMETRICAL BRANCH, SURVEY OF INDIA.

Parts of TIBET, SIKHIM and BHUTAN

Published under the direction of Colonel G. C. DePree, R.E., Surveyor General of India and under the Superintendence of J. B. M. Hennessey, Esq., M.A., F.R.S., Deputy Surveyor General in charge Trigonometrical Branch, by Colonel H. C. B. Tanner, Bn. R.E., Deputy Superintendent.

Hill shading by Mr. J. Dutton

on which graze thousands of cattle, horses, and beasts of the chase. The mountains surrounding the Yámdok in some places recede to a distance of several miles, and the space between the foot of the hills and the water is either cultivated or left for grazing. Villages and monasteries surround the lake, and are dotted all along the small bays which so frequently indent its shores.

The Tibetans have bestowed upon the lake the very prosaic name, Yámdok, or scorpion-lake, in allusion to its shape, Nágartsi being at the extremity of the right, and Tag-lung of the left claw; the tail is at Eoh-bu Jong. It is difficult to understand how, without a map, the Tibetans could have been aware of the resemblance the shape of the lake has to that of a scorpion; and as the delineation of the lake in the Lama's maps bears out this resemblance, they presumably have maps which give a fairly correct idea of the shape of the lake. As a matter of fact, the lake, which was first visited by D'Anville in 1735, has been shown in all the old Himalayan maps, but inaccurately as regards both its geographical position and its size. The Pandit connected with the Survey Department, who visited it in 1866, made a round guess as to its circumference, which he believed to be about 45 miles; but as neither the Pandit nor any previous explorer had examined any but its western section, they could not have had any complete idea as to its actual dimensions. It is a singular merit on the part of the Lama that he cleared the map of this lake district of everything which was not the result of positive information. Many high hills or mountains dip their spurs precipitously into the waters, and cause an endless variety in the scenery.

On the mountain tract, which is nearly encircled by the two scorpion claws, or the western arms of Yámdok, is an inner lake, Dumu-tso, with a circumference of some 24 miles, and elevated above Yámdok as much as 500 feet. This sheet of water is regarded by the Tibetans with great awe, fear, and superstition. There is an idea that some day Tibet is doomed to be flooded, and all animal life destroyed by the overflow of this lake; and prayers are constantly being offered up in the surrounding monasteries to avert the catastrophe. Earthquakes, landslips, and convulsions, accompanied by subterraneous noises, are said to be of constant occurrence, and the waters are reputed to be steadily rising, notwithstanding the precautions taken by the monks, who continually offer up their prayers to turn away the wrath of the demon of Dumu-tso, said to be confined below the waters.

Yámdok-tso has been called indifferently Piahté or Pálti or Pedé, simply because one of the best known and most frequented towns on the northern shore is a resting-place on the high road between Shigatsi and Lhása. Yámdok, however, is the true name. Its altitude above the sea is determined at 13,800 feet by the Lama, and previously at 13,700 by other explorers. The circumference, including the bends of the shore, is about 170 to 180 miles, and by the regular road which crosses many spurs of the encircling mountains, 120 miles. There is a large population on the banks, and much cultivation. An old account states that there was a great export of salted fish from the neighbourhood of Yámdok, and that boats were much used; but the Lama reports that the traffic in fish has been stopped. The mountains which rise up near the centre of the lake are assumed by the Lama to attain about 18,000 or 19,000 feet, which would place the summit of the highest one 4,000 feet above the waters. On the whole, lake Yámdok must be about as charming a spot as one could well find anywhere; and I cannot conceive a more exhilarating trip than a gallop across the soft turf of the "starry plains," followed by a row over the lake, and finally an ascent up the central mountains, whence the beautiful scenery of the neighbourhood might be enjoyed.

A number of much used, but little known, routes lead away from Lake Yámdok. One over the Thib La pass *viâ* Kodesho Jong (Kidishor) and Tungo La (16,330 feet high) to Lhása was followed some years back by D. C. S., who has kindly supplied me with names of places on the road. The Thib La is very high indeed, and a very difficult pass. From the summit D. C. S. saw some very high snow-clad mountains towards the north-east, situated somewhere on the watershed of the Ki-chhu and Brahmaputra, and he supposes them to be more lofty than any he has seen in any part of Tibet, except amongst the Everest group. A third well-frequented road leads from Tag-lung (pronounced Tálung) on the south-western corner of Yámdok to the Lhobrak* (pronounced Lhobra) country. It was followed by the Lama, and will receive a few words of notice presently. These routes, and the interesting countries they pass over, have never until now been made known. The map of the Himalayas showed pure white paper, or at most dark lines of imaginary hills, which were inserted to give continuity to the Himalayan chain, and existing maps do not even hint at any of the Lama's geography.

Thib La. Tungo La.

It may not seem a difficult matter to decide whether a lake such as Yámdok has an outlet or not; yet, though a circuit of it has now been made, this question is still to a certain extent an open one. The Lama's exploration embraced a re-survey of the Rong valley, and he distinctly affirms that he saw the waters of the Yámdok flowing westward through the Rong valley into the Brahmaputra. We know that the height of the water in the Yámdok is very variable; and the Lama states that when the water of the Brahmaputra is higher than that of the Yámdok, the latter receives a supply from the river; but when the water in the lake is the higher of the two, the flow is the other way. Though D. C. S., however, does not confirm this, I conclude that the Lama is right. He is a careful and intelligent observer, who is not

* Lho=south.

likely to have mistaken the direction of the flow of water down the Rong valley when he marched its whole length from the Brahmaputra to the lake.

The Lama left Yámdok at Tag-lung (Tálung), and crossing the Yeh La pass (17,000 feet), descended into the basin of the Pho Mo Chang Thang* lake (16,050 feet), one of the highest in all Tibet. This newly-discovered lake is surrounded by high mountains which leave a fairly broad margin of grass land along the shores. It has no outlet for its waters. A nomadic tribe of pure Tibetans inhabits the margins of Pho Mo Chang Thang; they speak Tibetan, and are not to be confounded with the Gálokh who occupy the Tibetan highlands to the west and north. The height of the lake is over 16,000 feet, at which altitude there is no cultivation whatever; the circumference is about 46 miles.

The basin of Pho Mo Chang Thang was left by a depression in the surrounding mountains in the south-east corner, and the Menda La (written Manda La) pass, which leads into the Indian drainage, was crossed. At the foot of the Menda La, the Lhobra river was met with, flowing from some high mountains to the westward. At or near the foot of the pass the mountain sides were sparsely covered with juniper; lower down with the Dun-san pine of Sundakphu; and at Lha-khang Jong,† where the Lhobra was a large river, with pines and the forest common to Upper Sikkim.

The Lama did not travel along the Lhobra valley, but turned off south by the Tum La pass to visit a monastery situated at the foot of Ku Lha Kangri, one of the four holy mountains of Tibet proper. From the Lama's description I should suppose the altitude of Ku Lha Kangri to be from 23,000 to 24,000 feet. I think it has no glaciers, for there is a monastery in the bottom of this valley at the very foot of the mountain. There are some lakes formed by glacial action close at hand, but I cannot make the Lama understand the difference between perpetual snow, *névé*, and glacier.

The Bhutan frontier is two days' journey southward from Lhá-kháng Jong, at an important place called Dumt-sang, where there is a frontier post, where those beautiful *repoussé* silver dagger sheaths which are sometimes offered for sale in the Darjeeling Bazar are made, and it is a wonder how people living almost as barbarians can produce articles so artistic as the sheaths noticed. Dumt-sang I have been unable to find on any map.

Some uncertainty appears to prevail regarding the vegetation of Tibet, and especially so with the trees: very large pines clothe the slopes of the Lhobra valley at a certain altitude, and the same fact was noticed by explorer No. 9, who crossed from Tibet to Towang, and who styled them "enormous." The Lama describes the Lhobra pines as being identical with the common pine of Sandakphu, the Dúng shing of Sikkim, and the Gobari sala of the Nepalese. A high authority on such matters has informed me that the Sandakphu pine is the *Abies Webbiana*. But as Webb, after whom the *Webbiana* is named, never, I believe, visited Sikkim, and travelled much in the Western Himalayas, the identity of the *Webbiana* of the Western Himalayas with the common pine of Sandakphu cannot be established. No two kinds of pine can be more unlike; the Webbianna of the Western Himalayas is tall, gradually tapering from its root to a pointed summit; its trunk is evenly and fully clothed from top to bottom with a regular succession of short branches, but the pine of Sandakphu spreads out cedar-like at the top, or has an umbrella head, whilst its trunk is almost destitute of branches. Very often it is scarcely to be distinguished from the Deodar. There is also a remarkable and peculiar curve or sweep of the branches, which I have not seen common to any other tree.

Now that the Lama's work has been combined with that of other explorers who have preceded him in the region between Sikkim and Lhása, the map reveals a very curious system of drainage that prevails in the part of Tibet under notice, namely, that the chief feeders of the Brahmaputra run for the greater length of their course in a contrary direction to that of the chief river of Tibet, or in other words, the sources of the affluents of the Brahmaputra are situated towards the direction in which that river flows. This is the case with the Ki Chhu, the Rong Chhu, the Shang Chhu, the Tong Chhu which flows past Thab-den monastery, the Nyang or Paina Chhu, and lastly, the Rhe Chhu which rises between the Lá-Mo La and La-Ngoi La passes.

The high lands near the head of the Lhobra are said to be the home of the Shao, the magnificent stag of Tibet. The other animals in the valleys are identical with those found in Sikkim.

From Lhá-kháng Jong, the most southerly place reached by the Lama, the Lhobra river was seen flowing away to the south towards Bhutan through a deep gorge. This river must be one of the largest, if not the very largest, feeder of the Monas, but we know so little of Bhutan that it is hard to say which of the streams crossed lower down by Pemberton is the one explored by the Lama.

A trade route leads from Lhá-kháng Jong to Dumt-sang in Bhutan *viâ* Náling, Libo, Kurti, Tincho Pet, Tunkar, Tápé, Takachi, and Chákosum, thence crossing the Chatsi Pikla pass *viâ* the Shuchung monastery, Leling Jong (Tindu Jong), Khomá Yalamdung, Shinká Takteng, Pujur Tsing dong, to Dumt-sang, an important place where arms are manufactured.

The boundary of Tibet is met at Náling, where duty is levied, two days from Lhá-kháng Jong.

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* Pho Mo=man and wife.

† Lha-khang=God's house, *i.e.*, temple.

Leling Jong is probably "Ling-Tsi-Zong" of Pemberton.

From Lhá-kháng Jong the Lama ascended the north-eastern branch of the Lhobra, and crossed out of the Indian drainage into the region of neutral drainage by the Shar-kha-leb La pass. The ascent was fairly easy, but the descent on the other side quite imperceptible, the pass leading up to a regular plateau called Tigu,* a desert on which is situated the extensive lake Tigú-tso (15,500 feet high). This was skirted by the Lama for some five or six miles, and then the Che La pass (17,000 feet high) was crossed, and the head of the fruitful and populous valley of Yarlung was entered.

Tigú-tso is a fine body of water, with a circumference of 38 miles. It may have an outlet towards the south-east, but though the Lama saw a depression in the mountains in that direction, through which there might be an exit for the waters, he was unable to obtain certain information on this point.

From the Che La, a splendid view was obtained of the group of peaks composing the Yar-Lha-Shang-Pu, one of the four holy mountains of Tibet. The mountain cannot be very high as supposed by the Lama, for the monastery of Kang-gyi-oo (15,500 feet high) situated in the bottom of a valley is within 2½ miles of the summit of Yar-Lha-Shang-Pu.

The Yarlung valley is the pleasantest and the most populous in all Tibet. At its lower and northern extremity fruits grow in profusion, and unlike the slopes of Western Tibet, the hills are forest-clad. Monasteries of note are numerous, and shelter thousands of monks.

The journeys made in Tibet by the Lama in years previous to 1883 will only receive a passing notice from me, although the geography collected in these journeys has been shown on the Lhása map. The most important of these journeys are two: one which traversed from Shigatse along the left or north bank of the Brahmaputra to Thán-den monastery, and thence on to Pon Shendarding; and the other from Janglatsi Jong through Sákya to Khámba Jong. Pon is the name of the ancient religion of Tibet which was almost extinguished by Bhuddhism. The map shows by the prefix "Pon" those places where the religion, of which we shall know more when the reports of D. C. S. are made public, still has votaries.

From Pon Shendarding the Lama travelled by a new route to the great monastery of Sákya, which is for many reasons only second in importance to Lhása. From this place he went by a road not marked previously in any map to Tashi Tso (Tashi Chuïding of explorer No. 9), at the south-west corner of Lake Tso Mo Tel Thung, a fine sheet of water, 44 miles in circumference. Explorer No. 9 in 1871-72 skirted the western, while the Lama in 1882 followed the southern shore. Pho Mo Tel Thung may or may not have an outlet for its waters, for although the Lama, at a short distance from the lake, crossed a stream flowing in a direction away from it, he could not make up his mind on this point.

On the western bank of the lake the Sikkim Raja has a *jagir* which was presented by the Tibetans some time back to his father or grandfather.

Besides the journeys here noticed, the Lama has made others, but owing to his want of a thorough knowledge of route surveying, the geographical information he might have brought back with him has been lost to us. Thus the route from the Kang La on the north-west frontier of Sikkim to Khamba Jong cannot be mapped. The journey was a very arduous and trying one owing to the height of the passes met with. It was in that journey when in company with D. C. S. that the two together crossed the high Nai Jin Sáng Ra, and then after traversing the elevated region at the head waters of the Zemu river, found their way by the Chorten Nyiama to Khámba Jong.

One very plain fact may be gathered from the notes furnished by the Lama, namely that Tibet in summer is as delightful as in winter it is wretched. In summer the land is covered either with crops, with luxuriant waving grass, or with soft velvety turf; streams flow in every valley, and all nature is bright, sparkling, and fresh, but in winter king frost reigns supreme; all vegetation is dried up, the trees are leafless, and a cold, cutting wind tears over the face of the land, raising clouds of dust, and forcing its way through the ill-made doors and windows of the houses.

Game is abundant in Tibet, but one cannot learn much about it. There appears to be a great objection to taking animal life, and those of our countrymen who in the last century visited Tibet complained of the obstructions put in their way when they wanted to shoot.

There is a great difficulty in arriving at a suitable method of spelling Tibetan proper names. I have attempted to render them on the map so that they may be recognized by travellers, but the system employed may be objected to by those who know Tibetan. One of my difficulties has been this, that the Lama differs sometimes with D. C. S. The latter is no doubt a high authority, but the Lama, I should suppose, would be more likely to give the names as he has heard them pronounced by the common people of the country. Some of our explorers, not knowing Tibetan thoroughly, have occasionally made a great mess of Tibetan names, a number of which, as they appear on the maps, cannot be recognized either by D. C. S. or by the Lama.

In most cases I have adopted the spelling of D. C. S., and I am indebted to him for having taken the trouble to revise most of the names which appear on the map.

Another lake it was my duty to report on was the Sar-i-Chashma-i-Aba Sind, otherwise Gház Kul, at the head of the Kunar branch of the Indus, situated in Lat. 36°·54′ Long. 74°, and accepted by the inhabitants of Gilgit,

Lake Gház Kul.

* Tigu=fish.

Yasin, and the Baroghil country as *par excellance* the source of the Indus. The name is by no means uncommon, another lake of the same name being at the head of the most southerly feeder of the Oxus and separated from that under discussion by the undulating spurs of the Barojhil range, *i.e.*, the Hindu Kush. That at the head of the Kunar branch was known by hearsay to Asiatic geographers before the exploration of M.—S., the Kashmir Syud, fixed its position, and in my opinion is identical with Hayward's Karambar Sar or Tshkarmam Sar, whose waters flowing under a glacier pour into the valley of that name.

The people of Yasin and the adjacent tracts are aware of the peculiar way in which the glacier nearly closes up the outlet into the Karambar valley, and Hayward received his information from them. He, however, was murdered in the Yasin valley, at a spot only two or three days' journey from the lake, just when about to cross over into the Karambar valley with the object of exploring the lake of that name.

The explorer travelled from the Barojhil highlands along the right bank of the Kunar river until he reached the lake Ghâz Kul or Sar-i-Chashma-i-Aba Sind at its head, and from a spot on the northern shore was pointed out the gap through which the Baroghil people stated the waters were discharged into the Karambar valley. The people described how the glacier, sometimes advancing and sometimes stationary, either blocked up this outlet or allowed the water to pass beneath the ice, and how great noises "like the firing of guns" were made by the water in its sub-glacial passage.

General Walker was inclined to suppose that the Syud's Sar-i-Chashma-i-Aba Sind and Hayward's Karambar Sar were two different lakes, but against this supposition I urged that the region embraced between peaks trigonometrically fixed by myself was not extensive enough to contain two large lakes. In making the map I had barely room for the insertion of one.

The region about lake Ghâz Kul has rather the aspect of a tract in the Arctic zone than one pertaining to an Indian system of drainage, and the constant movement of great masses of ice gives rise to peculiar and strange topography not found in ordinary mountain regions. The freaks and vagaries of glaciers moving on steep gradients produce sometimes unexpected and startling phenomena, of which we know very little; and considering that the evidence regarding the two outlets of the lake obtained by "The Syud" from the people of Barojhil was quite independent of that furnished to Hayward by the people of Yasin, I think the chances are greatly in favour of my theory, that there are two outlets to the lake under notice, and that there is only one lake called indifferently Sar-i Chasma-i-Aba Sind and Karambar Sar, and not two lakes as supposed by General Walker.

Major Biddulph penetrated a considerable distance up the Karambar valley till confronted by glaciers barring further progress; had he reached the head of the valley, this interesting lake question would have been cleared up.

It was from the Karambar valley that the water, long pent up by a glacier which had broken away from a side ravine, and had been precipitated into the main valley, suddenly bursting the ice dam, swept down the Gilgit and Indus valleys, and devastated a vast region as far as Attock, and causing the Kabul river to flow backward on its course, inundated the cantonment of Nowshera.* Could the identity between the Syud's Sar-i-Chasma-i-Aba Sind and Hayward's Karambar Sar be established, the lake might with great propriety be named after Hayward, who lost his life in so courageously endeavouring to explore it.

Extract from the Narrative Report of MAJOR A. W. BAIRD, R.E., *Deputy Superintendent in charge Tidal and Levelling Operations;—season* 1883-84.

THE levelling operations under Mr. Belcham extended from Chikhalvohol (the closing point of the levelling done in 1877-78) near Dhulia in Khándesh, to the Sironj base line, having been carried *viâ* Mhow and Bhopal.

Thus the line of levels from Kurrachee, through Sind and the Punjab, to Dehra Dún and thence *viâ* Delhi along the great arc series has been joined to the line of levels from Bombay, which was carried to Kalyân, Igatpuri, Dhulia, Mhow, Bhopal, and Sironj. The termini of this very long chain of levels are the tidal stations at Kurrachee and Bombay; and the determination of the mean level of the sea has been obtained at both places with great accuracy.

We are thus enabled to apply a very rigid test to the levelling operations, and the result is a highly satisfactory one, viz. that the error in levelling over this immense distance is only 0·624 foot, or 7½ inches.

The volume of tide tables for 1885 will contain the predictions of high water and low water for the same number of ports (20) as the tables for 1884, and the actual values of the co-efficients to be employed in setting the tide-predicting machine have this year (for

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* *See* Drew's work on Kashmir.

It is strange that Kailas mountain in Western Tibet is not considered one of the four holy mountains, but the Lama never seemed to include this region in Tibet proper.

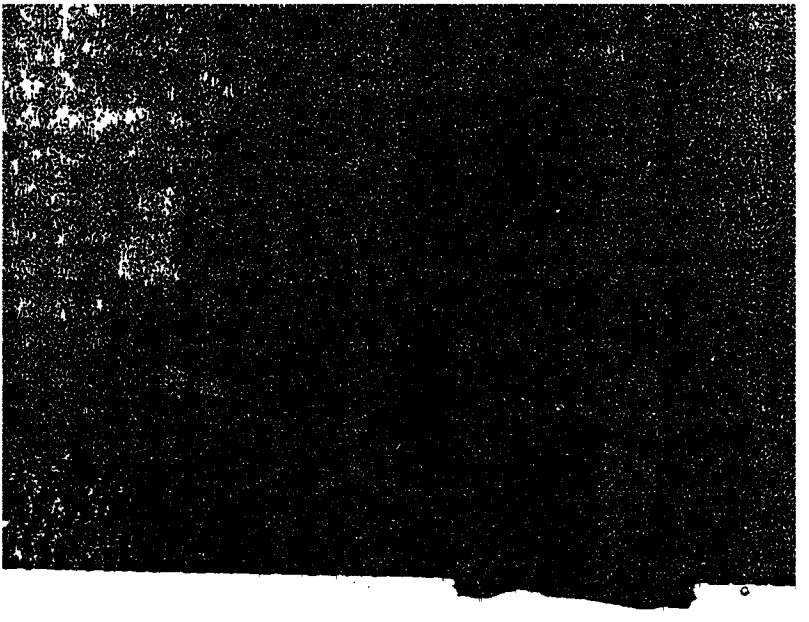
The four holy mountains are Ku La Kangri, Yár Lhá Shámgpu, Nuijin Káng Sáng or Há-o-Káng Sáng, and Nuijin Thánq La, near Tengri Nur lake. With the exception of the last, they are shown on the Lhasa sheet.

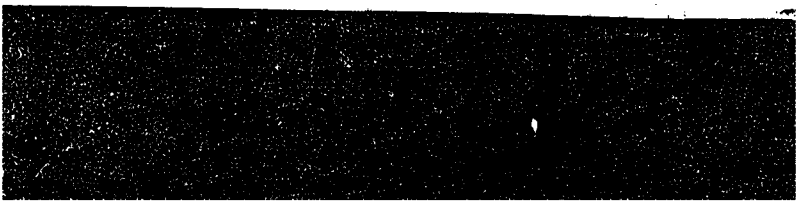
Ghâz Kul = Goose lake.

Sar, Kul or Kol = lake.

Bar = stream or valley.

NOTE.—Corrections to pages 18 to 40 of the Appendix to the last General Report of the Survey of India Department (1882-83), the Narrative Report on the Tidal and Levelling operations, will be found at the end of this Volume.





the first time) been sent to Mr. Roberts. The form in which the various co-efficients are now determined, according to Professor Darwin's suggestion, enabled me to make *one* determination of the *mean value* of the amplitudes of each tidal co-efficient from each year of observation; and by taking the average value of all these means we obtained a very near approximation to the true value of the mean amplitude in each case. Then, by applying the proper factor we determined (R) the throw of the crank and (ζ) the angle at which the crank had to be set in each case for 0 hours, 1st January 1885, at every port. Thus, Mr. Roberts will not only have been saved a great deal of trouble in calculating, but the values sent him are more rigorously determined than those formerly computed by him, and the predictions ought to be all the more exact.

It is most satisfactory to learn that the predictions given in the tide tables are improving as we obtain more data from new observations. A regular return is submitted monthly from each observatory showing the comparison between actual and predicted heights.

Another pamphlet (No. 2) of auxiliary tables has been prepared and printed for use in the office, to enable the computers to reduce the observations and obtain the results according to the lines laid down by Professor Darwin. The calculations made for this table occupied the office for a considerable time in the early part of the year.

It was necessary to extend the results obtained by former years' work in order to determine values (H and κ) of the various co-efficients of each tide according to the method which Professor Darwin proposed, and this was a piece of work of considerable magnitude in the shape of computations; and much credit is due to Mr. Connor for the way in which he and his computers worked to turn it out quickly.

The Marine Survey Department has from time to time been supplied with information as required. The military authorities in British Burma have been supplied with a complete copy of the meteorological statistics for Amherst from August 1880 to 31st July 1884 in compliance with their request. The information was required, so that Government may consider the advisability of establishing a sanitarium there.

The working of each observatory will now be briefly reported on, commencing with Aden, then Kurrachee, and so on, taking each station in order round the coast.

Aden.—At Aden, the tidal registrations were excellent during the past year. There was only one stoppage of the clock, and that was only for four hours; and on one occasion the wire connecting the pencil traveller and the float-wheel broke: it was at once replaced by a new wire, and hardly any loss of work occurred. With these two exceptions, the tidal observations have been continuous and uninterrupted.

A new anemometer, somewhat larger than the old one, was set up at Aden in November 1883. It continued to work very well until the 17th September 1884, when the clock ceased to go. I was passing Aden about that time on my way out from England, and of course landed to see the state of the observatory. So I arranged with the Port Officer to have the anemometer clock cleaned. This has been done, and the wind observations were resumed on the 1st October. The self-registering aneroid has worked without a single break during the past 12 months.

The observatory was inspected, and the whole of the instruments were thoroughly cleaned by Mr. Rendell in October 1883. Much of the success of the observations at Aden is due to the excellent supervision which Captain Thyne, the Port Officer, exercises, and I am greatly indebted to him for the interest he takes in our work.

Kurrachee.—Soon after the date of my last annual report this observatory was inspected by Mr. Rendell, and he had the instruments overhauled and cleaned by the native mechanic who accompanies him. Since then there have been eight stoppages of the tide gauge work at various times, but only for an hour or two at a time.

The anemometer here is a large one, belonging to the Port authorities. On two occasions it failed to register properly, and it had to be repaired. The self-registering aneroid has been working satisfactorily throughout. My acknowledgments are due to Mr. Price, the Port Engineer, for his hearty co-operation in the work, and I attribute the successful working of the Kurrachee observatory to his supervision.

Bombay.—At Bombay there has been absolutely no interruption in the continuous registration of the tidal observations. This observatory has always given extreme satisfaction; but such a perfectly continuous record, viz. since December 1882 (when the instrument was cleaned in the usual course) up to the present date, is unprecedented at any station. The clerk deserves much praise for the careful performance of his duties. On two occasions the wire attached to the pencil traveller and the counterpoise weight broke, and he at once repaired the damage, so that no work was lost.

Marmagão.—At the beginning of March last I proceeded to Marmagão to start the operations at that station. The small observatory, which was formerly at Kárwár, was removed during the preceding year, and erected on the pile pier recently constructed by the Railway authorities. The instruments which were in use at Kárwár were sent to England in the autumn of 1883, and were thoroughly repaired and considerably modified and improved in accordance with my suggestions by Messrs. Légé & Co. of London. The new instruments having arrived, were sent down to Marmagão in February last, and were stored there till I arrived. I must here observe that it is entirely due to the interest taken by Mr. E. Sawyer, the Engineer-in-Chief of the West India Portuguese Railway, that the tidal operations at Marmagão have been started. During my stay at Marmagão, Mr. Sawyer gave me great assistance and met my wishes in every way.

The apparatus was completed, and the observations were started on the 14th March 1884. Since March last the tide gauge clock has only stopped once, and then only for three hours;

but on the 23rd June the German silver chain which connected the sheave attached to the float-wheel with the pencil traveller (and which had been substituted by Légé & Co. for the silver wire formerly used) broke. Although a piece of silver wire was put on in its place by Mr. Good, the gauge would not work well, and the chain was repaired and replaced on the 25th June. All went well till the 7th September, when the chain again broke, and the wire was once more substituted. This portion of the apparatus will be attended to at the next inspection; meanwhile everything is progressing very well with the tidal registration.

The self-registering aneroid barometer gave much trouble at first by the clock continually stopping, and it was not till the 5th of May, after it had been overhauled by the native mechanic, that it worked satisfactorily. Since then it has only stopped once. The anemometer did not work properly until the 23rd May, when it was re-started by the sub-surveyor, Dhondu Vinayek, after being cleaned by the mechanic. On the 17th June it had to be again repaired. Thus the meteorological observations have been anything but satisfactory hitherto, and it is to be hoped they will improve in future.

Major Hill, R.E., visited the observatory in May, and Dhondu Vinayek, sub-surveyor, was told off to stay for some time at Marmagão to teach the clerk his duties.

Beypore.—At Beypore the self-registering tide gauge has continued to work most satisfactorily. Only once during the past 12 months has its clock stopped, and then it was re-started after 9 hours' break in the registration.

In December 1883 the float-cylinder was flushed out, and the old pipe which connected it with deep water was removed and a new one laid down. In August last, and again on the 7th of the present month, the cylinder was flushed out, as there was a certain amount of retardation noticed in the flow of the water through the pipe on account of the gradual settlement of fine mud causing a partial choking of the pipe.

The self-registering aneroid has worked without a single break since last year.

The anemometer gave much trouble for the first three months of the present year: the instrument has been in constant use so long that it wants a thorough repair. Another anemometer, which had formerly been at Pámban and which was put in order by Messrs. Légé & Co. of London, was set up at Beypore on the 8th April, and the instrument has worked capitally ever since.

I inspected the Beypore observatory in December; again in May last Mr. Rendell inspected this station, and during his visit the whole of the instruments were cleaned by the native mechanic.

A new mercurial barometer was put up in May at Beypore, and the old one sent to the Mathematical Instrument office for repair. The clerk in charge of the observatory at Beypore performs his duties most creditably.

Colombo.—In December the Government of India sanctioned the sum of Rs. 1,700 for the construction of the tidal observatories at Galle and Colombo. Correspondence on this subject had been going on for some time, and it was hoped that the Government of Ceylon would so far assist in the operations as to defray the cost of the erection of the observatories, on the understanding that the instruments would be supplied, and the salaries of the clerks for each observatory be borne by the Government of India; but the Ceylon Government were unable to sanction the expenditure of the amount.

Meanwhile I had made every preparation for the immediate commencement of the observations pending the allotment for the construction of the observatories: the instruments which were in use formerly at Pámban had been remodelled and put in excellent order by Messrs. Légé & Co.; and these instruments as well as the self-registering tide gauge which was exhibited at the Venice Geographical Congress (and which was kindly lent for the Ceylon operations by the Master Attendant at Madras) were despatched to Colombo, and were lying ready to be set up. The observatory formerly in use at Pámban was ordered to be sent round to Colombo in a native boat, and I had placed myself in communication with the Public Works authorities and with the Masters Attendant at Galle and Colombo, so that all preliminary arrangements were completed before January.

I received a te egram from the Surveyor-General when I was at Beypore informing me that the Rs. 1,700 was sanctioned; and I proceeded to Colombo as soon as possible.

On arrival at Colombo the site for the observatory was selected, viz. at the end of the Government pier and between the pier and the stone-work pedestal of a huge crane. Within a fortnight the observatory was erected,—a result due to the help I received from Mr. Churchill, the Director of Public Works, who took considerable pains to get the work pushed on, and who assisted me most kindly in every way, both at Colombo and Galle.

I arranged with the Surveyor-General of Ceylon to obtain copies of the meteorological observations taken at his office, and as these were made with great care and exactness, there was no necessity for our setting up a self-registering anemometer and self-registering aneroid.

The tide gauge was started at Colombo on the 24th January, so that within one month of the time of sanction by telegram the observatory at Colombo was fitted up, placed in position on the supports which were constructed for it, and the instruments set up: this is the quickest piece of work of the kind we have ever done.

Captain Donnan, the Master Attendant, has a very neat electric apparatus for determining the time from Madras. He arranged matters so that the semaphore signal in connection with this apparatus should be observed by the clerk at the tidal observatory, and then the clock could be properly rated. The clock being a pendulum one, there have been

several stoppages on account of the bumping of boats against the side of the pile pier, but, these stoppages were only for an hour or two on each occasion. The end of the pier Mr. Rendell informs me, has been isolated from the remainder, and the stoppages of the clock have been fewer of late, but I intend to substitute one of the new spring-escapement clocks which we have just received from England, and then it does not matter whether there is any shaking in the observatory or not. There have been a few mishaps in the shape of the float-band coming off the stud-wheel, and the pencil tearing the diagram on two occasions; but the interruptions in these cases were unmportant. There is a continuous small oscillation of the water at the end of the harbour at Colombo, which goes on both during a rise and during a fall of the tide; even when the surface water is perfectly calm, the inlet hole near the bottom of the float-cylinder was large enough to admit of the water inside the cylinder being subjected to this oscillation, and this caused the tidal curves to be recorded in a series of zig-zig lines across the true tidal curve: consequently when the diagrams were received it was impossible to follow the work on account of the mass of wavy lines, even though each day's record had been inked in with different coloured ink.

In June last a small 2-inch pipe, with a block of wood inside it, and having a tube of $\frac{5}{8}$th-inch diameter running through its centre, and also having on the top a cone of copper which had a $\frac{1}{4}$th-inch hole at its appex, was fixed on to the inlet hole near the bottom of the cylinder: a "rose" or perforated nozzle covered the mouth of this small 2-inch pipe. The result of this modification in the apparatus has been to give us clear curves which are easily followed: the oscillations referred to are not obliterated from the tidal curves, but are so far lessened that the work of one day is seen quite distinct from that of another.

I am much indebted to Captain Donnan, the Master Attendant, for the supervision he exercises over the clerk in charge.

Galle.—While the erection of the observatory was progressing at Colombo I went down to Galle to make a start in the work there.

The site of the observatory is at the end of a pile pier close to the Master Attendant's office: the float-cylinder stands in 7 feet of water at low-tide, and the two inlet holes of about $\frac{1}{4}$ an inch diameter are close to the bottom, so that any roughness on the surface of the water outside is not felt inside.

After the clerk at Colombo had been taught his work, the sub-surveyor proceeded to Galle, and was engaged there from the 15th February until the beginning of April.

Captain Blyth rendered much assistance in getting the work pushed forward, and the instruments which had been sent round in the Government steamer from Colombo were set up and tested by the middle of March.

On the 23rd March the observations were commenced, and the sub-surveyor remained till the beginning of April teaching the clerk, who is one of the Port Officer's clerks, his duties; a second clerk was also taught so as to be available in case of accident.

Thus the two new observatories in Ceylon were established, and the registrations were well begun in less than three months from the time the work was commenced. The tide-gauge at Galle is the one formerly used at Pámban, considerably modified and improved in accordance with my suggestions by Messrs. Légé and Co. It has a spring-escapement clock, and is similar to the instrument set up at Marmagão. The anemometer is a large new one by Messrs. Légé and Co., and the self-registering aneroid, formerly at Pámban, had also been put in good order by that firm.

The clock of the self-registering tide-gauge has only stopped once (for two hours) since the observations were commenced.

On the 6th September the float cylinder was slightly shifted by a heavy sea, so it was got up, and it was not till 18th that it was refixed in position and properly secured. Thus an interruption of 11 days occurred.

The anemometer was set up on the top of the observatory and not on a separate small house, to be erected near the Master Attendant's house as I wished it to be, but on account of the inconvenience it would have been to the clerk, unless a special man had been appointed, Captain Blyth decided to set it up on the observatory. The site is undoubtedly bad, and I hope yet to have it placed in a more favourable position. The anemometer clock has stopped three times since it was started, but was re-started within a few hours on each occasion.

The aneroid clock stopped 10 times between 23rd May and the 23rd June. On the 24th June this instrument was given to a watch-maker to look at; it was set up again on the 27th June, and since then there have been four short stoppages.

The clock will require thorough overhauling by our native mechanic at the next inspection.

The observatory was inspected in the middle of April by Mr. Rendell.

Negapatam.—The observations here are most satisfactory. Except when the instruments were taken to pieces and cleaned in May, the tide-gauge has worked without a single break during the past year.

The self-registering aneroid has given a perfectly continuous registration also, and the anemometer clock only stopped twice.

This observatory was inspected by myself in December and again by Mr. Rendell in May: during the latter inspection the instruments were taken to pieces and cleaned by the mechanic.

Madras.—The observations continued without interruption till June, and on the 28th of that month they were suspended for a time pending alterations in the roof of the observatory to admit of some lighting apparatus being placed on it.

On the 22nd July the tide gauge was again started: since then the self-registering tide gauge clock stopped five times, and was re-started within two hours on each occasion: then on the 29th August the clock had to be again sent to the watch-maker, and it apparently took more than a month to repair.

Thus the Madras tidal registrations for the past year are by no means good, as more than two months have been lost.

A self-registering aneroid, which had been lying unused at Madras for some considerable time, was repaired by the mechanic during Mr. Rendell's inspection in April, and was set up in the Master Attendant's office and started. In July it was necessary to hand this instrument to the watch-maker for repair, and it worked then all right till the 29th August, when it was reported as needing repairs again. As in the case of the tide gauge clock, a month was lost in effecting the repairs, and the observations were resumed on the 1st of October.

I inspected this observatory in December, and Mr. Rendell inspected it in April last.

Vizagapatam.—There were a series of interruptions in the tidal observations during the first six months of the year under review.

The observatory was inspected by Mr. Rendell in February, during which time the instruments were taken to pieces and cleaned by the native mechanic. Since then the tide gauge has stopped 10 times, and from 5 to 12 hours' work has been lost on each of these occasions.

Mr. Rendell again visited this observatory in April, and since then there have been five stoppages of the self-registering tide gauge clock of from 1 to 3 hours each.

Regarding the anemometer, there were only two stoppages of the clock during the year: thus we may consider that this instrument has worked very well throughout.

The self-registering aneroid has given an almost continuous registration for the whole year Mr. Rendell reported when he inspected the observatory in February that there was a good deal of friction in the action of this instrument.

On the 4th August it was reported that the aneroid was out of order. The Port Officer re-adjusted the instrument himself, and had it promptly replaced in the observatory.

The Port Officer at Vizagapatam heartily co-operates with me in taking the observations, and I am much indebted to him for his interest in the work.

False Point.—The observations here have not been at all satisfactory. The continual stoppage of the clock of the self-registering tide gauge is much to be regretted, and one of the new spring-escapement clocks will be substituted for the present one as soon as possible. From the beginning of September 1883 up to 9th December there were no less than 27 stoppages of from three to nine hours each. There were two short stoppages in March, six in April, two in May, and one stoppage in each of the months June, July, and August, and three in September.

With regard to the self-registering aneroid, it had worked very well up to December 1883, and the stoppages which have been few and of short duration were caused by the vibration of the observatory. The instrument was cleaned during Mr. Rendell's inspection in December 1883. After this there were about 15 short stoppages before the 28th February, when Mr. Rendell again visited the observatory. On examining the instrument he found it necessary to alter the position of the steel rod which gives motion to the pendulum, and also to raise the endless screw which gears with the cog-wheel on the diagram barrel Since then the instrument has worked most satisfactorily.

Regarding the anemometer, the velocity gear had ceased to work for several months previous to Mr. Rendell's inspection in December 1883, and one of the four large new anemometers recently received from England was set up at False Point. The other three large anemometers were set up at Aden, Moulmein, and Galle. I may here make a few remarks about these new instruments.

Messrs. Légé & Co. had made two mistakes in the instrument, one of which was in the construction of the clock and the other in the printing of the diagrams. The effect of the clock error was that in 24 hours of time, as shown by the dial, rather more than 25 hours of the diagram had been registered. The error in the diagram was made by having the direction lines printed as N., N.-W., W., S.-W., S., S.-E., &c., instead of N., N.-E., E., S.-E., S., S.-W., and so on. With regard to the latter error, a correction in red ink could be applied to the heads of the diagram. This was done. Messrs. Légé & Co. were promptly informed of the circumstances, and a supply of new diagrams with proper headings ordered.

As regards the clock error, I went to see Messrs. Légé & Co. while I was in England, and the fault in construction of the clock was acknowledged by them. They are supplying me with new clocks properly constructed to replace the others, and these I expect to receive in a few days: the old clocks will be returned to Messrs. Légé and Co., and of course no charge against Government is to be made. The diagrams which have been used hitherto will have their time-lines altered, as required, in due course. Since the new anemometer was set up at False Point it has worked most satisfactorily.

I have already alluded to Mr. Rendell's inspections, viz. in December 1883 and at the end of February 1884. A new clerk for the observatory was appointed in September last, as the former clerk got another situation at False Point which carried better pay; the change was permitted on the distinct understanding that the new clerk should in the first instance be thoroughly taught the work, and then if anything went wrong that the former clerk should give any assistance from time to time as required. I regret to say that the new clerk seems to suffer as much from fever as the old clerk did, and he frequently has to miss some of the times for visiting the observatory; but fortunately up to the present time he has always gone at least once a day to his work.

Dublat.—There have been a great number of stoppages of the tide gauge clock, viz. about four or five times per mensem, from 4 to 12 hours on each occasion. These stoppages are solely due to the vibration in the observatory. The same remark applies to the aneroid clock. The anemometer has only stopped working once, for 10 hours, during the whole year; its clock having a spring escapement is not stopped by the vibration in the observatory.

I am endeavouring to have this observatory strengthened so as to lessen the vibration, and I hope to see the Port Officer at Calcutta soon and arrange matters with him. In any case, a new spring escapement clock will be fitted to the tide-gauge and a new self-registering aneroid with a spring escapement clock will be set up at Dublat during the next field season. Mr. Rendell inspected this observatory in March, and he reported that the instruments were working most satisfactorily, and that the stoppages were, as above stated, due to the vibration of the observatory staging.

Mr. Rendell reported very favourably on the clerk, that he took an interest in his work, and kept the instruments in good order; also that the observatory was neat and clean.

Diamond Harbour.—There were a few stoppages of the tide gauge clock in October and November 1883 and in January 1884, but they were only for a few hours on each occasion. In March 1883 it was cleaned during Mr. Rendell's inspection; since then there were six stoppages, of from 7 to 12 hours each, prior to the 3rd July, when the steel rod giving motion to the pendulum was found to be broken; this was put all right immediately, and work was resumed on the 4th July. After this there were eight stoppages in July, and the clock was then sent to Calcutta for repair; it was returned on the 3rd August, and since then has only once stopped. The aneriod has worked most satisfactorily and not a single stoppage has occurred. The anemometer too has been working capitally: there had been one or two stoppages previous to Mr. Rendell's inspection in March. These he found to be due to the diagram barrel not moving freely in its supports, and since he had this rectified only one stoppage has occurred.

Kidderpore.—The work at this observatory has been most satisfactory.

The tide-gauge clock has stopped four times during the past year. Mr. Rendell inspected the observatory in March, and had all the instruments and their clocks taken to pieces and thoroughly cleaned. Previous to his inspection the anemometer clock had stopped eight times, for a few hours each time, in the month of January; since then it has only stopped three times.

The aneriod has worked without a break during the past 12 months.

Thus the observations in the Hooghly have been progressing most satisfactorily, and I would here beg to express my acknowledgments to Lieutenant Petley, R.N., Conservator of the Port, for the interest he takes in our work and for his hearty co-operation in conducting the operations.

Rangoon.—In September 1883 the working of the float-band on the stud-wheel was found to be faulty; and on three occasions the registration was impeded. It was found that the end of the band had got entangled at the bottom of the float-box, which was damaged: a new float-box was fitted up in November. The observatory was inspected in January by Mr. Rendell, who reported that the self-registering tide-gauge was working most satisfactorily.

Since that time there have only been five stoppages, each of a few hours.

The anemometer has worked without stoppage during the past 12 months.

The clerk at Rangoon performs his duties to my entire satisfaction. He is a very smart man, and it is of great importance having such a good man here, because if any interruption occurred at Rangoon or at Elephant Point, he would most probably be able to set matters right and keep the observations going.

Elephant Point.—In my report for last year I explained the cause of the delay in resuming the observations at this station. Mr. Darlington, Vice-Chairman of the Port Commissioners, took much interest in the matter, and the new observatory was removed from the wrong site and placed in the Pulokah creek, at the place which Major Rogers had selected. The observatory was ready for the reception of the instruments by the 1st of September 1883, and Mr. Darlington telegraphed to me to send some one to start the observations. Mr. Rendell went to Elephant Point as soon as it was possible, and the first tidal diagram at this station was placed on the self-registering tide-gauge on the 30th December, so that the observations were well started by the 1st January 1884.

The clerk in charge was placed under the immediate supervision of the Telegraph Master, and the Superintendent of Telegraphs at Rangoon arranged that the Telegraph Master at Elephant Point should visit the tidal observatory once a week.

The anemometer was erected on the "Look-out House" near the Telegraph office, and the aneroid and mercurial barometers are in the Telegraph office. The duplicate tidal heights are registered by the Telegraph Master. Excellent arrangements were made by Mr. Rendell for the clerk in charge being periodically changed with the clerk in Rangoon.

The float and band have occasionally to be removed to clear out the mud which settles in the float-box.

The clock of the tide-gauge had only stopped twice, for a few hours each time, between January and September, but latterly there have been six stoppages of from one to three hours each time.

The aneroid and anemometer have been working most satisfactorily, not a single stoppage of the former instrument being reported.

I am much indebted to Mr. Jennings, the Port Engineer at Rangoon, for the trouble he took in getting the observatory properly erected.

The success of the tidal operations at Rangoon and Elephant Point is due in a great measure to the hearty co-operation of Mr. Darlington, and but for his assistance I should have been at a standstill on many occasions.

Amherst.—In the month of September 1883 the clerk discovered that the gauge was not working satisfactorily, and on examining the stop-cock, by means of which the accumulation of air is exhausted from the pipe which connects the float-cylinder with deep water, he found a washer missing; he tightened the screw, after which the gauge worked properly. Another similar occurrence took place in April last. It is usual to have the float-cylinder and connecting pipe flushed out once a fortnight. This necessitates the removal of the float and band. In June a hole was discovered in the cylinder, about eight feet from the bottom, so that the flushing could not be carried out. On the 6th July the hole was stopped, and thus the work was only suspended for a few hours.

The tide-gauge clock has worked remarkably well, and there have been no stoppages since October 1883. The wire connecting the pencil-traveller with the float broke on the 27th May; thus the instrument ceased to record the curve, and the band had come off the stud-wheel. The clerk put matters right immediately he visited the observatory, and inserted a new wire. On the whole, we may consider the past year's observations satisfactory.

Twice during the month of September the observatory was broken into, and the tide-gauge put out of order: entrance had been effected by smashing the window panes. The Port Officer, Moulmein, has ordered a wooden shutter to be made for the window; but as the observatory has been broken into on former occasions, I have addressed the Secretary to the Chief Commissioner and solicited his assistance to prevent such wanton mischief.

The aneroid has been working without interruption, and there have been but one or two stoppages of the anemometer clock.

Mr. Rendell during his inspection in January reported the anemometer as being very dirty, and that it had not been attended to properly. The direction gear was out of order, and altogether this instrument was in a most unsatisfactory state. The clerk was reprimanded.

Moulmein.—There have been a good many stoppages of the tide-gauge clock, about three or four per mensem, between January and September, but these were only for an hour or so on each occasion.

On the 7th September the greater part of the float-box was carried away by, it was supposed, some heavy piece of half-submerged timber coming down against it. While a new box was being prepared the clock was given to the watch-maker to be cleaned. I have just heard by telegram that the observations have been resumed, but over a month's registration has been lost.

A new anemometer, one of the large ones, was set up by Mr. Rendell during his inspection in January last.

The aneroid and anemometer have worked without stoppage during the past year.

I am greatly indebted to Captain Dodd, the Port Officer, for the assistance he gives me. It is mainly due to his supervision of the Amherst and Moulmein observatories that we are securing good observations.

Port Blair.—The observations at this station were most excellent; in fact, all the instruments have worked uninterruptedly since the date of last report till the 10th September 1884, when the Port Officer wrote to say he had stopped the work for a few days until he had the float-cylinder repaired, as there were some holes in it. The post from Port Blair is unfrequent, and I heard nothing more till the beginning of October, when I was thunderstruck to find that the Port Officer actually proposed stopping the observations, as he supposed now that good tide tables had been secured, it was not worth while repairing the cylinder and pipe. I telegraphed to the Chief Commissioner, and begged him to have a wooden box at once set up for the float to work in, pending the repairs of the cylinder, that the work must on no account be stopped, and that the Port Officer was quite under a misapprehension as to the scope of the operations.

I am afraid some six weeks' work at least will be lost, and this is most annoying, for it was quite unnecessary, as the holes in the cylinder must have been gradually formed, and it should not have been removed without my permission, unless to have it very quickly repaired and set up again.

Port Blair, from a scientific point of view, is one of our best stations: the observations are first-rate, and the results are most valuable; we were getting a continuous record of the tidal curves, and this stoppage is a great blot.

Spirit levelling operations.—These operations have been again carried out by Mr. Belcham during last field season, and sub-surveyor Narsing Dass worked the second level.

After examining the instruments, comparing the staves, and testing the stability of the Chikhalvohol bench mark, Mr. Belcham commenced operations on the 14th of November. Continuing along the Bombay-Agra Road through Dhulia, the party reached Mhow on the 22nd January. This section of the work was 170 miles in length, and passed over the Tápti and Nerbudda rivers and through the Sátpura and Vindhya ranges at Mhow. Mr. Belcham laid down a bench mark in the railway station compound, and having obtained permission of the Executive Engineer of the Indore State Railway, he worked along the railway as far as Indore (13 miles), and placed a number of bench marks on the principal bridges and level crossings.

Reporting on the remainder of the work, Mr. Belcham writes:—"At Indore I again got on to the high road, and worked along it as far as Dewás, at which place I took the more

direct route through Sehore, Bhopal, and Bhilsa to Sironj, and reached the south-west end station of the base on the 4th April. This section was 200 miles in length; between Dewás and Bhopal (120 miles) we had a very fair road to work on, but beyond Bhopal there was a very bad cart track which we had to make the best of.

"From the south-west end station of the Sironj base, I went on to the north-east station. The upper and lower mark-stones of both were connected, as directed. To effect this, I had first to remove the closing pillars and then the upper mark-stones, and after the observations I built up both the stations again, taking care to place the mark-stones as I found them.

"I must here mention that though the outward appearance of the south-west end station was good, yet on removing the closing pillar I found it to be merely a shell of brickwork, plastered over and filled in with loose earth and stones. The surface of the upper mark-stone was about 2 inches lower than the annular wall, and instead of the 4-feet pillar surrounding the mark-stone there was only loose earth, stones, and broken bricks mixed up with the roots of a large "babul" tree that had been allowed to grow alongside the station. I also observed that the surface of the lower mark-stone was considerably tilted towards the side the tree was growing, but the masonry surrounding it was firm and solid. From enquiries made on the spot I gathered that many years ago the station had been tampered with by thieves in quest of treasure, but I could not get any authentic information from the officials at Sironj regarding it. A full description of the state in which the station was found has been entered in the records of the levelling operations.

"My next duty was to continue the levels to Surentál H. S. and Mohasa bench mark, both of which had been connected with the line of levels from Kurrachee. This entailed an additional 26 miles of levelling, but the results obtained proved most conclusively that the south-west end station of the Sironj base had been tampered with, and besides it established a more rigorous check on the two lines of levelling."

The levelling throughout was carried on in the rigorous method which General Walker laid down. The "rectangular" level was used by Mr. Belcham for the whole time. Cylindrical level No. 1 was used by sub-surveyor Narsing Dass for the first 170 miles, when it broke down, the focussing screw having worn away so much that it became useless; he then used "Cushing's reversible level" for 42 miles, but as this was not found very well adapted for long lines of levels, Mr. Belcham reported the matter to me, and cylindrical level No. 4, which had just been repaired at Calcutta, was sent direct to Mr. Belcham.

Regarding the connection of the trigonometrical stations Mr. Belcham writes: "Three stations of the Khánpisura Series were connected, Anakwári H. S. (2,244 feet), Singárchori H. S. (2,891 feet), and Thikri H. S. (855 feet). The two former were very precipitous near the summit, and were connected with great trouble and danger to the instruments and the party. These were the only stations lying anywhere near the line of levels, and I was determined not to pass them without connecting them. I also connected Gidgarh H. S. and Kámkhera H. S. of the great arc series, the two ends of the Sironj base and Surentál H. S., making in all eight trigonometrical stations."

The total amount of levelling executed during the season was over 425 miles, and the total rises and falls nearly 22,000 feet. To accomplish this outturn, Mr. Belcham says they had to work longer than usual, and such a large outturn is certainly very creditable to him and his party.

Tabular Statement of outturn of work for the Field Season 1883-84 *by the Levelling Party under Mr. G. Belcham.*

During the month of—	No. of Miles. Double Levelling.		Total No. of Feet.		No. of Bench Marks, Embedded, Inscribed, and Connected.					
	Main line.	Branch line.	Rises.	Falls.	Embedded.	Inscribed.	Public Works Department.	Railway.	G. T. Survey Stations.	Kurrachee line bench marks.
	Ms. Chs. Lks.	Ms. Chs. Lks.	Feet.	Feet.	No.	No.	No.	No.	No.	No.
November 1883	40 11 84	3 76 96	1,578·0	1,396·5	3	41	.....	.....	1	.....
December	83 52 74	.....	2,550·9	2,389·6	7	69	.....	.....	.....	.....
January 1884	71 12 0	10 11 96	3,905·2	1,519·4	5	60	1	4	2	.....
February ,, ...	87 70 78	.....	1,496·6	1,403·7	7	33	.....	.....	.....	.....
March ,, ...	80 41 58	3 14 14	1,624·0	1,556·3	5	15	.....	.....	1	.....
April ,, ...	18 22 14	26 34 4	1,332·2	796·7	3	7	.....	.....	4	1
Total ...	381 51 8	46 67 10	12,502·9	9,382·2	30	225	1	4*	8†	1‡

Total No. of miles, double levelling ... 425 28 18

Total of rises and falls ... 21,885·1

* Level of rails at Mhow, Rao, and Indore Railway Stations (Indore State Railway).

† { Anakwári H. S., Thikri H. S., and Singárchori H. S. (Khánpisura Series).
{ Gidgarh H. S., Kámkhera H. S., and Surentál H. S. (Great Arc Series).

‡ { North-east and south-west stations, Sironj base.
{ Mohasa B. M. of the line of levels from Kurrachee *vid* Agra to Sironj.

Mr. Belcham says that the officials of the Khándesh and of the several Native States through which he passed afforded him great assistance, and that the arrangements for carriage and supplies, even in the wild parts of the Sátpuras and Vindhyas, were so perfect that he was not delayed for a single day.

The levels taken during the field season 1883-84 have just filled up the gap in the great chain of levels from Kurrachee *viâ* Mithankote to Dehra Dún, thence along the Great Arc Series to the Sironj base line, and on to Bombay. We have thus the means of testing the work along this enormous chain in a most rigorous way, viz. by comparing the mean level of the sea at Kurrachee and Bombay where accurate determinations of the sea level have been made by tidal observations.

If we take the bench mark, Surentál H. S., and the Mohasa bench mark, near the Sironj base, as the points for comparison, and we know that these stations have not been disturbed, we find that they are 0·607 and 0·640 of a foot respectively higher above the mean level of the sea at Bombay than they are above the Kurrachee mean sea level, or that the mean sea level at Bombay was 0·624 of a foot lower than at Kurrachee.

Now, in the Bombay-Madras levelling operations the discrepancy at Madras has been apportioned to the various bench marks along that line, and there was a correction of 0·360 of a foot at Kalyán; and as the line of levels to Sironj from Bombay may be said to emanate from Kalyán, we may apply this correction to all the heights up to Sironj, and the effect would be to make the mean sea level at Bombay *lower* than Kurrachee by 0·264 feet.

As a piece of levelling, I apprehend it will be acknowledged very good work to have such a small discrepancy as 0·624 of a foot between Bombay and Kurrachee. But the most important part of the result is, that it does not bear out the idea hitherto entertained, that the southern are apparently raised above the northern stations in great lines of levelling as was found to obtain between Bombay-Madras and Kurrachee-Calcutta, and which was considered probably due to oblique illumination of the bubble.

Connection of Kurrachee Tidal Observatory with bench mark at Trinity Church.

The values of the spirit level heights in Sind and on to Dehra Dún *viâ* Mithankote, and on to Calcutta are given in terms of mean level of sea at Kurrachee, the value of which had been determined many years ago by tidal observations extending over only two semi-lunations. In order to determine the accuracy or otherwise of this value of the mean sea level it was necessary to connect the tidal observatory with one of the bench marks of the line of levels. Mr. Rendell, assisted by Mr. Connor, carried this out last October and reports as follows:—

"The bench mark on Trinity Church, Kurrachee, was selected as a favourable point for connection. In order to carry the line of levels to this point it was necessary to level across Kurrachee harbour, which at its narrowest part is about half a mile broad. This was done by taking the mean of a series of observations with both the rectangular and cylindrical levels: the results, one instrument compared with another, agreed within one-thousandth of a foot. The bench mark on Trinity Church was thus connected with the mean level of the sea at Manora, and the value, when compared with that obtained in the first instance in 1855, agreed within 0·010 feet."

Revision of the Heights of the Khánpisura Series.

Last year Mr. Christie had brought this work southward from the Kurrachee Longitudinal Series to the side Jalalabad H. S.-Bábákuwar H. S. in latitude 21°-40′. Mr. Keelan was instructed to commence this season on the initial base of the series, viz. the side Agargaon H. S.-Chincholi H. S., and work northwards so as to close on the side where Mr. Christie had finished the previous season, and so complete the revision of the whole series. Mr. Keelan marched to Agargaon H. S. on the 15th November. The platform at this station was found to be out of repair, so the observations were not completed till the 17th November.

While at Agargaon Mr. Keelan was unfortunately attacked by severe inflammation of the right eye, and had to return to Ahmednagar for medical aid, and take privilege leave from the 1st December 1883 to the 15th January 1884. The loss of nearly two months of the best part of the season for observing was fatal to the attempt to complete the revision of the series, and so four stations of the Khánpisura Series still remain to be visited and observed at in order to complete the revision of the whole series.

Mr. Keelan says: "most of the pillars or platforms at the principal stations visited were found in a state of disrepair, or entirely destroyed. Thus only two stations, Dhaigaon and Walwari, were found with protecting masonry pillars built over the upper mark. The stations of Chincholi, Jámkhed, Ahirmat, and Rájur had masonry circular pillars, but no protecting structure built over them. All the remaining stations had only rough stone and mud structures, without any pillars, defining their positions, some in ruins and some with all mark-stones removed and platforms destroyed. Stations observed at were invariably repaired, and after observations protected by large cairns of boulders."

Mr. Keelan reports favourably regarding the native establishment, and that, with the exception of a few cases of fever and dysentery towards the end of the season, the health of the party was good. It is a matter of regret that the observations for the whole series were not completed; but considering the long break in his work, which was absolutely necessary,

and the delays he experienced, I think he did very well to visit and observe at 14 principal stations, besides the three subsidiary stations which he found necessary to establish.

Computations in the Poona Office.

At the head-quarters of the party at Poona, the computations for the reduction of the tidal observations have progressed most satisfactorily, and a vast amount of work has been completed. In my report last year under the heading "Evaluation of tidal constants" I pointed out that in accordance with Professor Darwin's proposals, the co-efficients would in future be presented as follows, viz:—(1) To tabulate the R's as formerly, and also to give the values of "ζ" in each case ("ζ" being the old uncorrected "ϵ"), so as to give the results of the analysis in the form R cos. $(nt-\zeta)$; (2) also to tabulate the H's and κ's so as to give the results in the form f H cos. $(V + u - \kappa)$, and the H's and κ's would be strictly comparable year by year.

Under the same heading I gave the definition of the various symbols H, κ, V, and u, and I have repeated the definition this year at the same place in this report.

To carry out this plan the first thing to be done was to have the computation forms modified so as to extend the analysis for the calculation of the H's and κ's. New computation forms were made up in England by Mr. Roberts under Professor Darwin's supervision, and I received 100 sets for the portion of the work which relates to short-period tides.

But these forms were only to be used in reducing *observations not yet analysed*; accordingly I had forms prepared in India suitable for determining the H's and κ's for all *observations already analysed as far as the evaluation of R's and ϵ's.*

I also prepared and had printed a set of auxiliary tables (No. 2) to facilitate the computations which were now necessary. The calculations for obtaining the data given in these tables were very considerable, and the tables themselves were necessary before we could take up the further analysis of the observations.

After this the determination of the H's and κ's was proceeded with. I am glad to say that we have been able to treat the whole of the observations taken in India as well as those referred to in the British Association reports for which we had data, so that by the end of June the values of the H's and κ's were obtained and thus made available for calculating the "constants" for the 1885 tide-tables.

It is difficult without going into detail to explain how great a piece of work this has been, and I must here record that Mr. Connor and his staff of computers worked splendidly to accomplish it. Besides the above, the regular analysis of the current work has progressed steadily, but of course it is somewhat in arrears. Regarding the analysis of the observations I should also mention that four new tides, three of which are compound tides, are now recognized, and have to be computed. This has thrown a very considerable addition of work on the office. Fortunately the computers are becoming more expert, and we are able to keep up the reductions fairly well, but from what I have stated it will be easily understood that the analysis of last year's observations is somewhat in arrears, and I can only report on the results for six out of 19 stations.

The Tide-tables.—The tide-tables for 1885 will contain precisely the same number of stations (20 ports) as the 1884 tables. The values of the constants were, as usual, sent to Mr. Roberts, but for this year these values have been prepared somewhat differently. I have alluded in the remarks under "Computations in the Poona office" to the determination of the *mean amplitudes* (H) and the *mean epochs* (κ) of each particular tide: when these were calculated for each year of all the observations at the various ports, we had a *series of values of the mean amplitudes* of each tidal co-efficient for each tidal station. These values were comparable *inter se*, and by taking the average of all the values we obtained a *final value as far as it could be determined* of the mean amplitude or semi-range for the particular tide.

By applying the proper factors, we calculated the *actual value of the amplitude and epoch of each particular tide which would be in force at the port in* 1885: these were the "constants" sent to Mr. Roberts, and they represented the *throw of the crank* and the *angle to which it had to be set for* 0 *hours*, 1*st January* 1885, for each of the constituents included in the predicting machine.

This is the first time we have been able to send Mr. Roberts the data in such a complete shape, and it now makes the arrangements for the tide-tables very satisfactory.

I might mention that Professor Darwin found a slight mistake in two of the formulæ given in the "Report to the British Association Tidal Committee (Southport, 1883)."

Two of the auxiliary tables which we had prepared were dependent on these formulæ; happily the error was detected in time, as Professor Darwin telegraphed to the India Office in London (he was in Italy at the time), and a telegram from the India Office on the subject was despatched to me. The auxiliary tables were at once corrected, and the values of the constituents affected by the error were promptly re-computed, so that the tide tables for 1885 were saved being burdened with the error. All this threw a great deal of extra work on the office.

While in England I discussed with Mr. Roberts a plan for improving the predictions at riverain stations, which I hope to carry out for the 1886 tables; for the 1885 tables we had to follow the method employed in the two previous years.

Up to the present time the Port Commissioners of Calcutta have printed tide-tables of their own. In the issue for last year a vast amount of information was given regarding

port rules, signals, &c. Lieutenant Petley, R.N., Conservator of the Port, wrote to me in the early part of the year suggesting that our tide-tables *only* should be published, and that all the extra information about port rules, &c., should be incorporated.

I of course concurred, and as he asked me to arrange for carrying it out at once, the tide-tables for the Hooghly for 1885 will be very complete, and will contain the extra matter referred to in *French* as well as in English. The Port Commissioners have agreed to bear the cost of the entire pamphlet. The extra matter, however, will not be given in the large volume for all Indian ports. The following statements have been drawn up giving the percentage and the amount of the errors in the predictions for the whole of 1883.

No. 1.

Statement showing the percentage and the amount of the errors in the Predicted TIMES *of* HIGH WATER *at the various Tidal Stations for the year* 1883.

STATION.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	698	45	40	7	5	3
Kurrachee	706	37	36	10	11	6
Bombay	705	52	41	4	3	...
Beypore	705	15	29	12	18	26
Madras	679	34	33	11	13	9
Vizagapatam	690	35	43	12	8	2
False Point	706	31	38	12	10	9
Amherst	701	30	35	13	17	5
Port Blair	706	35	42	13	9	1
Dublat	706	30	36	13	13	8
Diamond Harbour	703	28	38	11	15	8
Kidderpore	704	27	41	14	12	6
Rangoon	705	29	43	11	13	4
Moulmein	700	34	41	12	11	2

No. 2.

Errors in the Predicted TIMES *of* LOW WATER.

STATION.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	698	45	39	6	8	2
Kurrachee	706	39	37	11	9	4
Bombay	706	54	42	12	10	2
Beypore	706	16	19	9	13	40
Madras	679	37	33	12	12	6
Vizagapatam	679	36	40	9	10	5
False Point	705	29	38	11	14	8
Amherst	702	31	38	12	13	6
Port Blair	704	36	47	8	6	3
Dublat	706	28	33	14	15	5
Diamond Harbour	706	23	40	12	17	8
Kidderpore	705	24	40	15	16	5
Rangoon	704	26	38	15	16	5
Moulmein	700	30	41	12	12	5

No. 3.

Statement showing the percentage and the amount of the errors in the Predicted HEIGHTS *of* HIGH WATER *at the various Tidal Stations for the year* 1883.

STATION.	Number of comparisons between the actual and predicted values.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
		Per cent.	Per cent.	Per cent.	Per cent.
Aden	698	88	11	1	...
Kurrachee	706	81	16	2	1
Bombay	705	72	26	2	...
Beypore	703	84	14	2	...
Madras	679	76	22	2	...
Vizagapatam	680	62	28	9	1
False Point	706	78	17	4	1
Amherst	701	53	24	18	25
Port Blair	706	95	5	...	...
Dublat	706	21	27	26	26
Diamond Harbour	703	48	29	16	7
Kidderpore	704	35	30	19	16
Rangoon	705	50	30	15	5
Moulmein	700	36	25	23	16

No. 4.

Errors in the Predicted HEIGHTS *of* LOW WATER.

STATION.	Number of comparisons between the actual and predicted values.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
		Per cent.	Per cent.	Per cent.	Per cent.
Aden	699	86	13	1	...
Kurrachee	704	76	20	2	...
Bombay	704	76	22	2	...
Beypore	703	69	27	3	1
Madras	679	79	20	1	...
Vizagapatam	680	76	22	3	...
False Point	702	73	22	4	1
Arnherst	658	31	20	19	30
Port Blair	704	96	4	...	...
Dublat	703	23	24	22	29
Diamond Harbour	704	42	29	16	13
Kidderpore	705	24	28	22	16
Ramoon	705	45	27	15	15
Moulmein	700	42	19	14	25

Comparing these statements with those submitted last year, I find that, with one or two exceptions, the percentage of predictions, both for high and low water, within 15 minutes of the actuals is increased, which shows that the predictions for time for the last six months of the year 1883 were closer than they were for the first six months. As regards the height-predictions, there appears to be no improvement in the last six months of the year over the first six months, and in some cases, viz. the stations on the east coast of the Bay of Bengal, the height predictions are worse between June and December than they are for the first six months of 1883.

EVALUATION OF TIDAL CONSTANTS.

I shall only report on the results of the analysis of the observations which have been entirely completed during the past year.

As already explained, on account of having to extend the computations so as to determine the values of H and κ for all the work hitherto done, the reduction of the current observations is somewhat in arrears. However, the calculations for those stations which are *not* included in this report are in a very forward state, and the results of the short-period tides for most of them have also been deduced, but as the analysis is not complete, I shall defer discussing the results till next report.

The form in which the several tidal constants are now presented is different from that hitherto adopted. The constants are, however, divided, as usual, into two groups—one composed of the short-period tides, the duration of which in no case exceeds 24 hours, and the other of long-period tides whose duration ranges from a fortnight to a year.

In the harmonic theory of the tides, the principal constituents of the short-period tides are represented by fictitious stars moving in circular orbits at certain known velocities—the arguments of motion—in the plane of the equator. They are usually indicated by the letters M, S, K, O, &c. Each of these is in its turn composed of a number of tidal constituents also moving in circular orbits, but with different velocities which are mutually related, those of the second and subsequent constituents being twice, thrice, or some integral multiple of the first. Their periods are determined in the following manner. When the revolution of the fictitious stars is performed in or about 24 hours, the primary period is the one corresponding to the argument of motion of the star; when it is performed in or about 12 hours, the primary period corresponds to twice the argument of the motion of the star: the subsequent periods are fractions of the primary, corresponding to multiples of the velocity. The tidal constituents are sometimes called diurnal, semi-diurnal, ter-diurnal, quarter-diurnal, and so on; and the smaller of these are usually called *overtides*. These constituents are respectively distinguished by the subscripts 1, 2, 3, representing the relation of their periods to the primary period.

Three only of the fictitious stars, viz. S, M, K, have more than one constituent of sensible magnitude. The constituent which causes any fictitious star to produce its greatest effect on the sea level is rarely the first, and more frequently the second. Thus M_2 (lunar semi-diurnal) produces the greatest effect on the sea level, and after it S_2 (solar semi-diurnal) usually gives the next greatest effect. Sometimes K_1 (the luni-solar diurnal) is as great as the main solar tide (S_2): it is to this constituent (K_1) that the phenomenon of diurnal inequality, which is so marked a feature in the tides on the west coast of India, is chiefly due.

The constituents named $M_2 K_1$, MS, $2M_2 K_1$, &c., are compound tides. Regarding these tides Professor Darwin says: "It may be shown that the result of the interaction of two waves is represented by introducing two simple harmonic waves, whose speeds are the sum and the difference of those of the interacting waves. When the interacting waves are tidal, these two resultant waves may be called compound tides. They are found to be of considerable importance in estuaries."

Every tidal constituent is numerically expressed by two constants, R and ζ, where R is the semi-range of the tide in British feet, and ζ is an angle, such that $\frac{\zeta}{n}$ is the time elapsing

after 0 hours of the first day of the observations until it is high water of the particular tide, n being the speed of the tide in degrees per mean solar hour. It is obvious that ζ may have any value from 0° to 360°, and that the result of the analysis of successive years of observations will not be comparable with one another when presented in this form.

Again, the values of the amplitude (R) of the lunar and luni-solar constituents are dependent on the inclination of the moon's orbit, to the equator, and consequently vary from year to year.

The results of the analysis will therefore be given in the form of the values of H and κ as well as of R and ζ. Here H is the *mean value* in British feet of the semi-range of the particular tide in question; κ is the "epoch," and may be defined as the number of degrees of the orbit which the particular constituent has still to execute from the instant when the fictitious star crosses the meridian till it is high water of that tide.

By presenting the co-efficients in the forms of R and ζ as well as H and κ, we obtain the results of the analysis in the form. R cos $(nt-\zeta)$ and f H cos $(V+u-\kappa)$, and the H's and κ's are strictly comparable year by year. Professor Darwin explains V to be a linear function of the moon's and sun's mean longitudes, the mean longitude of the moon's and sun's perigees, and the local mean solar time at the place of observation reduced to angle 15° per hour. V increases uniformly with the time, and its rate of increase per mean solar hour is the n of the first method, and is called the "speed" of the tide.

It is supposed that u stands for a certain function of the longitude of the node of the lunar orbit, at an epoch half a year later than 0 hours of the first day of observation. Strictly speaking, u should be taken as the same function of the longitude of the moon's node varying as the node moves; but as the variation is but small in the course of a year, u may be treated as a constant and put equal to an average value for the year, which average value is taken as the true value of u at exactly mid-year. Together V+u constitute that function which has been tabulated as the "argument of the constituent tide."

H, as previously explained, is the mean value in English feet of the semi-range of the particular tide in question: f is a numerical factor of augmentation or diminution, due to the variability of the obliquity of the lunar orbit; for all solar tides f is of course unity; and for M_2, the principal lunar tide, $f=\frac{\text{Cos}^4\frac{1}{2}\ I}{\text{Cos}^4\frac{1}{2}\ \omega\ \text{Cos}^4\frac{1}{2}\ i}$, when ω=obliquity of the ecliptic, and i=inclination of moon's orbit to the ecliptic.

H is equal to $\frac{R}{f}$, and κ is equal to $\zeta + V_0 + u$, if V_0 be the value of V at 0 hours of the first day.

A_0 is the value of the mean level of the sea in British feet with reference to the zero of the gauge.

VALUES OF THE TIDAL CONSTANTS, ADEN, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Aden, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short-period Tides.

A_0=5·800 feet.

S_1	H =	0·094	M_6	R =	0·406	Q_1	R =	0·134	T_2	R =	.....
	κ = ζ =	165°·00		ζ =	310°·00		ζ =	67°·45		ζ =	.....
				H =	0·005		H =	0·138		H =	.....
S_2	H = R =	0·702		κ =	333°·12		κ =	59°·63		κ =	.....
	κ = ζ =	244°·77									
			M_8	R =	0·003	L_2	R =	0·028	$(MS)_4$	R =	0·015
S_4	H = R =	0·004		ζ =	323°·13		ζ =	344°·43		ζ =	2°·29
	κ = ζ =	244°·06		H =	0·003		H =	0·028		H =	0·012
				κ =	146°·48		κ =	194°·11		κ =	138°·22
S_6	H = R =	0·006									
	κ = ζ =	185°·01	O_1	R =	0·162	N_2	R =	0·436	$(2SM)_2$	R =	0·023
				ζ =	161°·40		ζ =	345°·41		ζ =	242°·40
S_8	H = R =	0·001		H =	0·050		H =	0·423		H =	0·022
	κ = ζ =	221°·63		κ =	57°·56		κ =	217°·27		κ =	106°·56
M_1	R =	0·094	K_1	R =	1·192	λ_2	R =	0·015	$2N_2$	R =	0·030
	ζ =	31°·04		ζ =	137°·87		ζ =	217°·85		ζ =	220°·28
	H =	0·066		H =	1·312		H =	0·015		H =	0·027
	κ =	50°·54		κ =	34°·47		κ =	135°·12		κ =	188°·17
M_2	R =	1·637	K_2	R =	0·170	ν_2	R =	0·143	$(M_2N)_4$	R =	0·047
	ζ =	88°·96		ζ =	261°·37		ζ =	79°·81		ζ =	64°·07
	H =	1·565		H =	0·215		H =	0·139		H =	0·044
	κ =	224°·80		κ =	233°·71		κ =	254°·24		κ =	71°·77
M_3	R =	0·020	P_1	R =	0·334	μ_2	R =	0·056	$(M_2K_1)_3$	R =	0·032
	ζ =	1°·16		ζ =	281°·61		ζ =	251°·52		ζ =	305°·18
	H =	0·019		H =	0·334		H =	0·81		H =	0·034
	κ =	204°·92		κ =	50°·91		κ =	103°·20		κ =	337°·56
M_4	R =	0·006	J_1	R =	0·114	R_2	R =	.....	$(2M_2K_1)_3$	R =	0·007
	ζ =	74°·41		ζ =	233°·75		ζ =	.....		ζ =	293°·43
	H =	0·004		H =	0·131		H =	.....		H =	0·007
	κ =	346°·08		κ =	39°·41		κ =	.....		κ =	308°·61

Long-period Tides.

	R	ζ	H	κ
Lunar monthly tide	0·017	153°·83	0·015	57°·30
,, fortnightly ,, ...	0·046	172·22	0·065	15·75
Luni-solar ,, ,, ...	0·012	6·92	0·013	231·08
Solar annual ,, ...	0·363	5·21	0·363	346·01
,, semi-annual ,, ...	0·114	160·92	0·114	122·51

The value of the mean level of the sea (A_o) for 1883-84 is 5·800 feet; the greatest discrepancy between any two values of the determination of the mean level of the sea at Aden is about $\frac{3}{4}$ of an inch, viz. between 5·754 in 1882-83 and 5·814 in 1881-82.

The mean amplitude of the main lunar tide (M_2) is 1·588 feet, which is the highest value yet obtained at Aden but it only differs from the lowest value, that obtained from the 1880-81 observations, by 0·03 of a foot. Regarding this tide it was remarked in last year's report that the amplitude was increasing year by year. This remark is only true as regards the amplitude R, but in no way refers to the mean amplitude H, which ought to come out year by year very nearly the same. The epoch of the main lunar tide is 224°·8. This value differs from that obtained in 1880-81 by 7°·2, which is a very large discrepancy, viz. nearly 15 minutes in time, but it should be remarked that if we neglect the 1880 value, which appears to be outstanding, the greatest discrepancy between any two years is only 3°·6, or about 7 minutes.

The main solar tide (S_2) has an amplitude of 0·702 of a foot, a value which agrees well with that obtained in former years.

The value of the main diurnal tide (K_1) is 1·312 of a foot, which is very accordant with the determination of the *mean* amplitudes (not the R's) of the former years. I should here state that the remarks made last year regarding the decreasing value of the amplitude are not applicable to the mean amplitudes (H) which are, as they should be, very accordant.

The main solar tide (S_2) at Aden for 1883-84 is 44 per cent. of the main tide; theoretically it ought to be 47 per cent., but this proportion is the same as has been observed in former years.

The principal diurnal tide (K_1) is 83 per cent. of the main tide for the year under discussion; theoretically it should be 58 per cent.; but at Aden this tide has always been found to be enormously large, and in 1877-78 it was actually within 6 per cent. of the main tide.

The proportion of the smaller lunar elliptic tide (L_2) is 0·018 against 0·028, the theoretical proportion, while the larger elliptic tide (N_2) is 0·266 of the main tide against 0·194, the theoretical value. This proportion for the latter tide is much the same as has been observed formerly at Aden.

The smaller evectional tide (λ_2) is, as it should be, quite insignificant, and approaches more nearly this year to the theoretical proportion than in any former year.

The larger evectional tide (ν_2) is nearly three times as large as it ought to be, viz. 9 per cent. of the main tide; for the last two years a close approximation to the theoretical proportion (0·038) was found to exist, but in 1879-80 and 1880-81 we obtained a proportion of about 9 per cent., as has also been the case this year.

With regard to the diurnal tides, the proportions to the main tide are as follow:—

	Aden, 1883-84.	Theoretical.
Luni-solar K_1	0·826	0·584
Lunar M_1	·042	·036
Solar declinational P_1	·242	·193
Lunar ditto O_1	·416	·415
Lunar elliptic J_1	·082	·033
Solar ditto Q_1	·099	·080

Thus it will be seen that at Aden the largest component of the diurnal tides (K_1), nearly half as large again as it ought to be, and that the next larger component (O_1) agrees well with the theoretical value; also that the other diurnal tides are from 1 to 5 per cent. greater than the theoretical values.

Regarding the overtides, with the exception of the ter-diurnal lunar (M_3), they are perfectly insignificant at Aden, but the ter-diurnal lunar tide, although barely appreciable, seems clearly to exist, as the results of each year come out almost precisely the same, and show that this overtide has an amplitude equal to 0·01 of the main tide, and its mean epoch would appear to be about 208°, the greatest variation from which is 11°·6, or about 16 minutes in time.

With respect to the compound tides, they are all very small at Aden.

The long-period tide which has the greatest amplitude at Aden is the solar annual, which appears to vary from 22 per cent. to 26 per cent. of the main tide; this year it is 23 per cent.

Its time of maximum would appear to be the 7th March, a date identical with that obtained last year; the greatest variation from this date is only 17 days in any of the five years during which the observations have been taken.

The next important long-period tide is the solar semi-annual, which is 7 per cent. of the main tide for 1883-84. This agrees very well with the mean of former values; its time of maximum is, however, somewhat variable; in 1879-80 it was found to occur on the 6th of May and November, while the following year it occurred on the 10th June and December; for the other years during which observations have been made the times of maximum fall between those dates.

The lunar monthly tide is quite insignificant at Aden according to the 1883-84 value; theoretically this tide should be 5 per cent. of the main tide, and it has been usually found at Aden to be between 2 and 4 per cent.

The luni-solar fortnightly tide does not appear to exist at Aden; compared to the main tide, at Aden we have never obtained a greater proportion than 1 per cent. On the other hand, the lunar fortnightly tide, which has a theoretical proportion of 0·086 of the main tide, is found to be at Aden for 1883-84, 0·041 in its proportion to the main tide; and in the last three years the proportion was from 2 to 3 per cent.; while in the two first years of observation, 1877-78 and 1879-80, the proportion was over 4 per cent.

VALUES OF THE TIDAL CONSTANTS, BOMBAY, 1883.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883 observations at Bombay, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883 observations:—

Short-period Tides.

$A_0 = 10{\cdot}267$ feet.

S_1	H	= R =	0·037	M_6	R	=	0·013	Q_1	R	=	0·111
	κ	= ζ =	164°·80		ζ	=	246°·11		ζ	=	200°·39
S_2	H	= R =	1·623		H	=	0·013		H	=	0·129
	κ	= ζ =	2°·46		κ	=	83°·41		κ	=	59°·33
S_4	H	= R =	0·003	M_8	R	=	0·008	L_2	R	=	0·030
	κ	= ζ =	5°·19		ζ	=	330°·36		ζ	=	60°·61
S_6	H	= R =	0·004		H	=	0·007		H	=	0·032
	κ	= ζ =	193°·09		κ	=	351°·34		κ	=	241°·72
S_8	H	= R =	0·001	O_1	R	=	0·570	N_2	R	=	1·017
	κ	= ζ =	53°·97		ζ	=	62°·92		ζ	=	314°·46
M_1	R	=	0·102		H	=	0·063		H	=	0·988
	ζ	=	87°·28		κ	=	47°·92		κ	=	313°·67
	H	=	0·007	K_1	R	=	1·273	λ_2	R	=	0·046
	κ	=	77°·25		ζ	=	208°·12		ζ	=	270°·25
M_2	R	=	4·157		H	=	1·293		H	=	0·044
	ζ	=	143°·74		κ	=	44°·94		κ	=	265°·57
	H	=	4·097	K_2	R	=	0·366	P_2	R	=	0·284
	κ	=	323°·94		ζ	=	141°·99		ζ	=	100°·87
M_3	R	=	0·064		H	=	0·355		H	=	0·276
	ζ	=	107°·21		κ	=	354°·77		κ	=	295°·76
	H	=	0·051	P_1	R	=	0·301	μ_2	R	=	0·212
	κ	=	24°·35		ζ	=	235°·25		ζ	=	253°·52
M_4	R	=	0·142		H	=	0·291		H	=	0·200
	ζ	=	316°·04		κ	=	44°·65		κ	=	293°·72
	H	=	0·134	J_1	R	=	0·096	R_2	R	=	0·045
	κ	=	326°·24		ζ	=	14°·02		ζ	=	112°·31
					H	=	0·109		H	=	0·046
					κ	=	40°·12		κ	=	291°·97

T_2	R	=	0·120
	ζ	=	51°·79
	H	=	0·120
	κ	=	52°·12
$(MS)_4$	R	=	0·161
	ζ	=	201°·72
	H	=	0·157
	κ	=	26°·82
$(2SM)_2$	R	=	0·037
	ζ	=	301°·10
	H	=	0·036
	κ	=	118°·00
$2N_2$	R	=	0·113
	ζ	=	117°·57
	H	=	0·110
	κ	=	290°·68
$(M_2N)_4$	R	=	0·131
	ζ	=	81°·96
	H	=	0·125
	κ	=	266°·15
$(M_2K_1)_3$	R	=	0·032
	ζ	=	193°·05
	H	=	0·034
	κ	=	214°·96
$(2M_2K_1)_3$	R	=	0·068
	ζ	=	256°·95
	H	=	0·070
	κ	=	70°·38

Long-period Tides.

	R	ζ	H	κ
Lunar monthly tide	0·039	267°·89	0·063	93°·39
,, fortnightly ,, ...	0·033	298·34	0·046	333·44
Luni-solar ,, ,, ...	0·045	15·50	0·044	190·40
Solar annual ,, ...	0·032	4·05	0·032	284·65
,, semi-annual ,, ...	0·157	344·70	0·157	185·89

The value of (A_0) the mean level of the sea is equal to 10·257 feet, which is slightly higher than the value obtained last year, and is a mean between the 1878 and 1881 values. The fluctuation in the values of mean level of the sea, as determined for different years at Bombay, is very slight; the highest value above the zero of the gauge was 10·265 feet in 1878, and the lowest value hitherto deduced was in the following year (1879), viz. 10·184 feet, or a difference of only one inch.

The mean amplitude of the main lunar tide (M_2) as derived from the analysis of the 1883 observations is 4·037 feet. Comparing this with the values obtained for former years, which have been calculated from the determinations of R given in former reports, I find that it approaches very closely to the average of all the amplitudes from 1878 to 1882. The epoch κ of this tide is 328·°84, the lowest value yet obtained, but it only differs from the highest (330·°66 in 1881) by 1·°82, or under four minutes in time.

With regard to the main solar tide (S_2), the value, 1·623 feet, agrees very well with that obtained in former years. I may here mention once for all that in the case of pure solar tides, the mean amplitudes (H) correspond with the amplitudes (R) given in former reports. The epoch of the main solar tide (S_2) is 2·°44 from the 1883 observations, almost precisely the same value as obtained in 1879. The greatest variation in the epoch of this tide at Bombay is 2·°74, or under three minutes in time.

The proportion of the main solar tide (H of S_2) to the main lunar tide (H of M_2) is 0·402; the theoretical proportion is 0·465; the proportion now obtained is the same as was found in 1880.

The amplitude of the smaller lunar elliptic tide (L_2) as compared with the main lunar tide (M_2) is only 0·008, the theoretical value being 0·028: this is the first time at Bombay where the discrepancy from the theoretical proportion has been considerable.

The amplitude of the large elliptic tide (N_2) in proportion to that of the main tide is 0·245, which is about 5 per cent. greater than the theoretical proportion, and thus agrees with what was found to obtain at Bombay from former observations.

The proportions of the two evectional tides (λ_2 and ν_2) to the main tide are precisely the same for this year as they were for last year, the smaller one (λ_2) having an insignificant amplitude, as it ought to have according to theory; while the larger component (ν_2) is 0·28 of a foot in amplitude, which is about double of what it ought to be as compared to the amplitude of (M_4) at Bombay.

The variational tide (μ_2) is again about double of its theoretical value as compared with the main tide, and this agrees with what has always been found at Bombay.

The luni-solar semi-diurnal declinational tide (K_2) is about 10 per cent. of the main tide; theoretically it should be nearly 13 per cent.; but except in 1877 and 1878 the proportion has been always slightly too small.

With regard to the diurnal tides, the largest (K_1), the luni-solar, is 35 per cent. of the main tide instead of 58 per cent., the theoretical proportion. This agrees with the 1880 value. The values for the three years previous to 1880 were from 37 to 40 per cent. of the main tide, and so were more in accordance with the theoretical proportion; for the years 1881 and 1882 the proportions were only 32 per cent. of the main tide, or a little more than half as large as they ought to be.

The next largest diurnal tide, (O_1) the lunar declinational, is 0·164 of the main tide; theoretically it should be 0·415; but the value now determined does not differ materially from that deduced formerly at Bombay.

Regarding the remaining diurnal tides (P_1, J_1, Q_1), they are all considerably less in their proportion to the main tide than they ought to be, the first being 0·097 instead of 0·193, the second 0·027 instead of 0·033, and the last 0·032 instead of 0·080. Thus it will be seen that the diurnal tides at Bombay are from one-half to one-third smaller in amplitude as compared to the main tide, than they ought to be.

Regarding the overtides, they are almost all insignificant, with the exception of the lunar quarter-diurnal (M_4), which is 3 per cent. of the main tide. This remark is equally applicable to the value obtained in former years; thus it may be said that the lunar quarter-diurnal is the only over-tide at Bombay which produces any effect on the sea level. I may remark about the ter-diurnal lunar tides, that it comes out every year at Bombay as about 0·015 of the main tides, or three times the theoretical value.

With regard to the long-period tides, the solar semi-annual has the largest amplitude, viz. 0·157 of a foot, which is 4 per cent. of the main tide, and agrees with the theoretical proportion, as has generally been found to be the case at Bombay. Its epoch appears to be about the 24th December and the 24th of June. Thus the presence of the semi-annual tide at Bombay seems to be perfectly established; its amplitude is, as it should be, 4 per cent. of the main tide, and its epoch would seem to vary between the 22nd of December and June as found in 1880, and the 13th of January and July.

The solar annual tide at Bombay is for 1883 quite insignificant. This tide has generally been found at Bombay to be 4 per cent. of the main tide. I am unable to assign any reason for the outstanding value obtained from last year's observations.

The lunar monthly tide is about 2 per cent. of the main tide for 1883; it should be from 4 to 5 per cent. theoretically, but the present year's value agrees fairly well with that obtained formerly at Bombay.

The lunar fortnightly and the luni-solar fortnightly have always been found to have very small values at Bombay, and this is the case in the present year.

VALUES OF THE TIDAL CONSTANTS, BEYPORE, 1882-83.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1882-83 observations at Beypore, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1882-83 observations :—

Short-period Tides.

A_0 = 5·395 feet.

S_1	R =	0·035	M_6	R =	0·013	Q_1	R =	0·067	T_2	R =	.....
	ζ =	172°·86		ζ =	189°·15		ζ =	156°·81		ζ =	.....
	H =			H =	0·012		H =	0·078		H =	.....
	κ =			κ =	132°·67		κ =	67°·28		κ =	.....
S_2	R =	0·359									
	ζ =	11°·68									
	H =		M_8	R =	0·010	L_2	R =	0·023	$(MS)_4$	R =	0·017
S_4	R =	0·007		ζ =	357°·17		ζ =	188°·75		ζ =	208°·01
	ζ =	147°·58		H =	0·009		H =	0·025		H =	0·016
	κ =			κ =	161°·87		κ =	1°·09		κ =	69°·18
S_6	R =	0·010		R =	0·307	N_2	R =	0·221		R =	0·007
	ζ =	247°·65	O_1	ζ =	3°·78		ζ =	218°·64	$(2SM)_2$	ζ =	211°·24
	κ =			H =	0·356		H =	0·215		H =	0·007
S_8	R =	0·001		κ =	55°·13		κ =	298°·94		κ =	350°·07
	ζ =	339°·44									
	R =	0·050	K_1	R =	0·607	λ_2	R =	0·011		R =	0·021
M_1	ζ =	54°·31		ζ =	240°·62		ζ =	313°·92	$2N_2$	ζ =	302°·18
	H =	0·032		H =	0·727		H =	0·011		H =	0·021
	κ =	90°·35		κ =	47°·07		κ =	354°·91		κ =	241°·81
	R =	1·030		R =	0·079		R =	0·054		R =	0·050
M_2	ζ =	102°·50	K_2	ζ =	225°·00	ν_2	ζ =	54°·71	$(M_2N)_4$	ζ =	49°·03
	H =	1·001		H =	0·098		H =	0·053		H =	0·047
	κ =	323°·67		κ =	17°·06		κ =	276°·57		κ =	350°·51
	R =	0·009		R =	0·211		R =	0·032		R =	0·009
M_3	ζ =	221°·74	P_1	ζ =	208°·49	μ_2	ζ =	156°·49	$(M_2K_1)_3$	ζ =	102°·95
	H =	0·009		H =	0·211		H =	0·030		H =	0·010
	κ =	193°·59		κ =	48°·46		κ =	238°·84		κ =	130°·57
	R =	0·027		R =	0·030		R =	.....		R =	0·004
M_4	ζ =	309°·04	J_1	ζ =	89°·05	R_2	ζ =	.....	$(2M_2K_1)_3$	ζ =	188°·97
	H =	0·026		H =	0·034		H =	.....		H =	0·004
	κ =	31°·39		κ =	39°·75		κ =	.....		κ =	104°·87

Long-period Tides.

	R	ζ	H	κ
Lunar monthly tide	0·065	262°·87	0·059	43°·74
,, fortnightly tide	0·032	47·32	0·044	345·31
Luni-solar fortnightly tide...	0·029	75 12	0·028	213·94
Solar annual tide	0·243	47·98	0·243	298·01
,, semi-annual tide	0·123	74·42	0·123	214·49

The value of the mean level of the sea (A_0) at Beypore for 1882-83, 5·395 feet, is slightly lower than that obtained for the two previous years, but agrees with the value for 1879-80. The greatest difference between the values for any two years is that between the 1878-79 value and that for 1881-82, viz. 0·027 feet, or about $\frac{1}{3}$ of an inch.

The mean amplitude (H) of the main lunar tide (M_2) is almost exactly 1 foot, and is the highest value yet obtained at Beypore. It differs from the lowest value, viz. that obtained in 1880-81, by 0·106.

With regard to the main solar tide (S_2), its mean amplitude (H) is also greater than for any of the former years, and differs from the least value (that for 1880-81) by 0·051 feet. The next largest tidal constituent, viz. the luni-solar diurnal (K_1), has also for this year its greatest value as compared with former years. The same remark applies to the lunar declinational tide (O_1) and to the solar declinational (P_1).

The proportion of the main solar tide to the main lunar tide for this year is 0·359; theoretically it should be 0·465, but this proportion agrees very fairly with the values noticed in former years, which vary from 0·342 to 0·371.

The lunar elliptic tides (L_2) and (N_2) agree well in their proportions to the main tide with their theoretical values, and this has always been observed at Beypore.

Regarding the evectional semi-diurnal tides in proportion to the main tide, the lesser component (λ_2) is about double of what it should be by theory, as has generally been found at Beypore, but this tide is insignificant in amplitude.

The larger component (ν_2) is 0·053 of the main tide, which agrees well with the proportion obtained for the first three years, and is about 2 per cent. greater than the theoretical value.

With regard to the diurnal tides, the following table shows the proportions to the main tides as obtained at Beypore, compared with the proportion which theory would assign :—

				Beypore, 1882-83.	Theoretical.
Luni-solar	K_1	...	...	0·726	0·584
Lunar	M_1	...	...	·032	·036
Solar declinational	P_1	...	...	·211	·193
Lunar ditto	O_1	...	...	·356	·415
Do. elliptic	J_1	...	...	·034	·033
Solar ditto	Q_1	...	...	·078	·080

It will be observed that three of these tides (M_1, J_1, and Q_1) agree well with the theoretical proportions, while the larger component (K_1) is 15 per cent. too great, but the proportion of this tide at Beypore to the main tide has always been found to be from 12 to 24 per cent. too large. The lunar declinational (O_1) is 6 per cent. less than it ought to be, but except in the first year of observation, 1878-79, the proportion of this tide to the main tide has always been somewhat less than the theoretical value. The solar declinational (P_1) is slightly larger than it ought to be: this was generally found the case at Beypore.

The only overtide of importance is the lunar quarter-diurnal, which is 3 per cent. of the main tide.

With reference to the long-period tides, the value of the lunar monthly is 0·059 of the main tide; whereas last year it was 0·159; theoretically it should be 0·046. The proportion this year is the nearest yet obtained to the theoretical value.

The lunar fortnightly tide for 1882-83 is only half as large as it ought to be; whereas in former years it was generally found to be too large.

The luni-solar fortnightly tide, which theoretically is perfectly insignificant, is at Beypore 0·028 of the main tide for 1882-83: the values in former years varied from 2 to 7 per cent. of the main tide.

The solar annual tide is for this year only 24 per cent. of the main tide; in the four preceding years it varied from 33 to 38 per cent.: its epoch for 1882-83 was found to be 14 days earlier than usual, giving the time of maximum to be about the 18th January.

The solar semi-annual is about half the size of the solar annual, viz. about 12 per cent. of the main tide, but at Beypore this tide has been found to vary from 16 to 28 per cent. of the main tide. Its time of maximum appears to be between the 20th June and the 12th July, or about the commencement of the S.-W. monsoon.

VALUES OF THE TIDAL CONSTANTS, NEGAPATAM, 1882-83.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1882-83 observations at Negapatam, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1882-83 observations :—

Short-period Tides.

A_0 = 2·048 feet.

S_1	H =	0·044	M_6	R =	0·014	Q_1	R =	0·006	T_2	R =	0·059
	κ = ζ =	99°·59		ζ =	187°·47		ζ =	139°·32		ζ =	228°·79
S_2	H = R =	0·277		H =	0·013		H =	0·007		H =	0·050
	κ = ζ =	285°·69		κ =	126°·07		κ =	218°·50		κ =	251°·78
S_4	H = R =	0·004	M_8	R =	0·004	L_2	R =	0·029	$(MS)_4$	R =	0·017
	κ = ζ =	166°·33		ζ =	270°·69		ζ =	163°·01		ζ =	356°·86
S_6	H = R =	0·000		H =	0·004		H =	0·031		H =	0·017
	κ = ζ =	163°·96		κ =	308°·82		κ =	278°·85		κ =	96°·39
S_8	H = R =	0·001	O_1	R =	0·077	N_2	R =	0·156	$(2SM)_2$	R =	0·006
	κ = ζ =	228°·37		ζ =	38°·40		ζ =	352°·07		ζ =	315°·64
M_1	R =	0·009		H =	0·089		H =	0·152		H =	0·006
	ζ =	97°·35		κ =	323°·24		κ =	245°·55		κ =	216°·11
	H =	0·006	K_1	R =	0·209	λ_2	R =	0·005	$2N_2$	R =	0·026
	κ =	72°·88		ζ =	173°·98		ζ =	253°·54		ζ =	172°·62
M_2	R =	0·748		H =	0·227		H =	0·005		H =	0·026
	ζ =	152°·52		κ =	345°·32		κ =	228°·84		κ =	219°·95
	H =	0·727	K_2	R =	0·068	ν_2	R =	0·048	$(M_2N)_4$	R =	0·034
	κ =	253°·05		ζ =	128°·89		ζ =	162°·44		ζ =	90°·71
M_3	R =	0·003		H =	0·082		H =	0·047		H =	0·032
	ζ =	344°·06		κ =	290°·62		κ =	206°·21		κ =	83°·72
	H =	0·003	P_1	R =	0·085	μ_2	R =	0·026	$(M_2K_1)_3$	R =	0·011
	κ =	133°·35		ζ =	155°·13		ζ =	273°·88		ζ =	273°·24
M_4	R =	0·019		H =	0·085		H =	0·024		H =	0·012
	ζ =	238°·10		κ =	350°·18		κ =	112°·94		κ =	184°·11
	H =	0·018	J_1	R =	0·014	R_2	R =	0·031	$(2M_2K_1)_3$	R =	0·007
	κ =	77°·16		ζ =	286°·55		ζ =	194°·86		ζ =	318°·81
				H =	0·016		H =	0·031		H =	0·007
				κ =	307°·30		κ =	349°·88		κ =	346°·64

Long-period Tides.

	R	ζ	H	κ
Lunar monthly tide	0·035	104·39	0·032	310·44
,, fortnightly ,, ...	0·012	268·59	0·017	335·46
Luni-solar ,, ,, ...	0·100	112·66	0·097	13·12
Solar annual ,, ...	0·522	337·69	0·522	232·64
,, semi-annual ,, ...	0·316	344·23	0·316	134·13

The value of (A_0) the mean level of the sea for 1882-83 is 2·048 feet against 1·996 in 1881-82, the first year of observations.

The value of the mean amplitude (H) of the main lunar tide (M_2) is greater than that obtained last year by 0·015 feet. Its epoch (κ) agrees remarkably well for the two years, the difference being only 0·8 of a degree, or less than two minutes in time.

The amplitude of the main solar tide (S_2) is almost precisely the same as the value obtained last year, and its epoch differs by less than 3°, or under six minutes in time from the 1881-82 value.

The diurnal tides (K_1, O_1, P_1, and Q_1) have amplitudes almost identical with the 1881-82 values; the epoch of the first is exactly the same as was found last year, for the second the difference is a little more than 3 degrees, for the third the difference is as much as 7½ degrees, while the epoch for the last (Q_1) is entirely different in value this year from what it was last year.

The proportion of the main solar tide to the main lunar tide is 0·381, or nearly the same as was found last year. It may be here mentioned that the proportion between these two tides is found to be less than the theoretical value at all the stations of the east coast south of False Point, the proportion gradually approaching the theoretical as we go to the north. The above remark does not apply to Pámban, where the proportion of the solar tide to the main tide was considerably greater than the theoretical value.

With regard to the diurnal tides, the proportions compared with the theoretical are as follow:—

	Negapatam, 1882-83.	Theoretical.
Luni-solar K_1	0·312	0·584
Lunar M_1	·008	·036
Solar declinational P_1	·117	·193
Lunar ditto O_1	·122	·415
Do. elliptic J_1	·022	·033
Solar ditto Q_1	·010	·080

Thus it will be seen that the proportions are all very much less than they ought to be, and with the exception of J_1, the proportions are all very accordant with those obtained last year.

Regarding the overtides, except the lunar quarter-diurnal, which is 0·025 of the main tide, they are all insignificant at Negapatam.

Of the compound tides $(M_2 N)_4$ is the greatest, having an amplitude equal to 0·044 of the main tide; and the tide $(MS)_4$ seems to be appreciable at Negapatam, being 0·023 of the main tide.

Regarding the long-period tides, the lunar monthly value this year agrees very closely with the theoretical one (0·046 of the main tide); last year it was found to be too large.

The lunar fortnightly tide, which in 1881-82 agreed fairly well with the theoretical proportion to the main tide, is this year only 0·023 of it.

The luni-solar fortnightly tide agrees very well in its proportion to the main tide with the value obtained last year, appearing to be about 12 or 13 per cent. of it.

The solar annual tide is 72 per cent. of the main tide; last year it was 75 per cent. At Madras this tide is only about 35 per cent., and at Vizagapatam about 48 per cent., while at Pámban it was only 25 per cent. of the main tide, and at Port Blair it appears to be only about 12 per cent. Its epoch seems to be very well determined, last year's value agreeing within two days of the value determined this year, and its time of maximum appears to be about the 12th November, shortly after the beginning of the N.-E. monsoon. At Vizagapatam the time of maximum appears to be about the 24th September, and at Madras about the 24th October, so that the date of the maximum effect of this tide appears to get later and later as we go south.

The solar semi-annual tide at Negapatam is also very large this year. Its proportion to the main tide is 44 per cent.; last year it was 55 per cent., and theoretically it should be only 4 per cent. Its times of maximum are about the 28th May and 28th November, the latter date being about the middle of the N.-E. monsoon.

VALUES OF THE TIDAL CONSTANTS, MADRAS, 1883-84.

The following are the amplitudes (R) and epoch (ζ) deduced from the 1883-84 observations at Madras, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short-period Tides.

A_0 = 2·180 feet.

S_1	H = R =	0·026	M_6	R =	0·006	Q_1	R =	0·002	T_2	R =	0·019
	κ = ζ =	87·°26		ζ =	71·°24		ζ =	19·°44		ζ =	45·°63
S_2	H = R =	0·436		H =	0·006		H =	0·002		H =	0·019
	κ = ζ =	279·°54		κ =	160·°40		κ =	65·°08		κ =	19·°34
S_4	H = R =	0·002	M_8	R =	0·002	L_2	R =	0·036	$(MS)_4$	R =	0·002
	κ = ζ =	216·°87		ζ =	150·°26		ζ =	96·°86		ζ =	240·°80
S_6	H = R =	0·091		H =	0·002		H =	0·037		H =	0·002
	κ = ζ =	56·°31		κ =	29·°13		κ =	237·°20		κ =	36·°52
S_8	H = R =	0·000	O_1	R =	0·062	N_2	R =	0·236	$(2SM)_2$	R =	0·019
	κ = ζ =	198·°44		ζ =	51·°31		ζ =	325·°24		ζ =	23·°63
M_1	R =	0·003		H =	0·056		H =	0·229		H =	0·018
	ζ =	36·°87		κ =	330·°09		κ =	244·°21		κ =	232·°71
	H =	0·003	K_1	R =	0·265	λ_2	R =	0·009	$2N_2$	R =	0·046
	κ =	61·°23		ζ =	115·°25		ζ =	255·°08		ζ =	181·°01
M_2	R =	1·065		H =	0·291		H =	0·009		H =	0·044
	ζ =	109·°70		κ =	342·°30		κ =	215·°60		κ =	229·°24
	H =	1·033	K_2	R =	0·092	ν_2	R =	0·061	$(M_2N)_4$	R =	0·043
	κ =	250·°41		ζ =	354·°78		ζ =	86·°51		ζ =	71·°70
M_3	R =	0·004		H =	0·116		H =	0·079		H =	0·040
	ζ =	102·°53		κ =	265·°23		κ =	235·°43		κ =	140·°39
	H =	0·004	P_1	R =	0·091	μ_2	R =	0·048	$(M_2K_1)_3$	R =	0·013
	κ =	57·°11		ζ =	205·°24		ζ =	250·°35		ζ =	274·°02
M_4	R =	0·003		H =	0·091		H =	0·046		H =	0·014
	ζ =	214·°99		κ =	344·°11		κ =	190·°23		κ =	290·°88
	H =	0·002	J_1	R =	0·019	R_2	R =	0·016	$(2M_2K_1)_3$	R =	0·005
	κ =	154·°83		ζ =	216·°81		ζ =	147·°72		ζ =	339·°59
				H =	0·022		H =	0·016		H =	0·005
				κ =	317·°89		κ =	357·°92		κ =	51·°89

Long-period Tides.

	R	ζ	H	κ
Lunar monthly tide	0·030	53·°99	0·027	284·°73
,, fortnightly ,, ...	0·031	293·°94	0·044	64·°58
Luni-solar fortnightly tide	0·024	179·°42	0·023	29·°70
Solar annual tide	0·520	253·°60	0·520	234·°73
,, semi-annual tide	0·300	236·°83	0·300	139·°09

The value of (A_0) the mean level of the sea at Madras for 1883-84 is 2·180 feet, and is precisely the same as that obtained last year, the values for the two former years being slightly greater; but the greatest discrepancy between any two values is a little more than $\frac{1}{2}$ of an inch.

The value of the mean amplitude (H) of the main lunar tide (M_2) is the lowest yet obtained, but only differs from the highest by less than $\frac{1}{2}$ of an inch: its epoch, however, has not been well determined, as there is a discrepancy of 3·°7 (about 7½ minutes in time) between the 1881-82 value and the value for the present year.

The amplitude of the solar tide (S_2) agrees very closely with the values obtained in the three former years.

The amplitude of the main diurnal tide (K_1) is precisely the same for all the four years of observation. The same remark may be said to apply to the diurnal tides (O_1, P_1,) and (J_1), while the solar elliptic diurnal tide (Q_1) has always been found to be perfectly insignificant at Madras.

The proportion between the main solar tide and the main lunar tide at Madras for 1883-84 is 0·422, which is somewhat closer to the theoretical proportion (0·465) than has been observed in the three former years.

With regard to the lunar elliptic semi-diurnal tides, the smaller component (L_2) is 0·036 of the main tide against 0·028, the theoretical value; the larger component (N_2) is 0·222 of the main tide for this year, and agrees very well with the proportions in the former years; theoretically it should be 0·194.

The smaller evectional tide (λ_2) is, as it should be, less than 1 per cent. of the main tide, but in former years it was found to be about 3 per cent. The larger component (ν_2) is 0·076 of the main tide, and agrees pretty well with the value obtained last year, but theoretically it should only be about half that value.

The main diurnal tide (K_1) is only 28 per cent. of the main tide, but this agrees with what we observed in former years; theoretically it should be 58 per cent.

The lunar diurnal tide (O_1) is 9 per cent. of the main tide, as was the case in the three former years; theoretically it should be 42 per cent.: the next largest diurnal tide (P_1) is also 9 per cent. of the main tide. This too was the case in former years; theoretically it should be 19 per cent. of the main tide: the other diurnal tides are very small, as has always been seen at Madras.

The over-tides at Madras are insignificant.

The only compound tide of any importance is the quarter-diurnal $(M_2, N)_4$ which is 0·039 of the main tide.

With regard to the long-period tides, the solar annual is half as large as the main tide this year; in former years the proportion varied from 32 to 42 per cent.; its epoch agrees very fairly well with what was observed in the three former years, the time of maximum being about the 24th October.

The solar semi-annual tide is 29 per cent. of the main tide for 1883-84; in the three former years it was seen to vary from 24 to 36 per cent.; theoretically it should only be 4 per cent., so this tide is obviously meteorological at Madras: its times of maximum appear to be about the 21st May and 21st November. The combination of the solar annual and solar semi-annual tides must therefore raise the water at Madras about the beginning of November very considerably.

The lunar monthly and lunar fortnightly are 0·026 and 0·043 respectively of the main tide, or almost half of what they ought to be by theory: in former years the lunar monthly tide agreed well with the theoretical proportion, but the lunar fortnightly has always been found to be half as large as it ought to be.

The luni-solar fortnightly tide, although exceedingly small, appears at Madras to be greater than it ought to be.

VALUES OF THE TIDAL CONSTANTS, MOULMEIN, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Moulmein, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short-period Tides.

A_0 = 8·737 feet.

S_1	H	0·009	M_6	R	0·102	Q_1	R	0·036	T_2	R	0·151
	R	=		ζ	190°·66		ζ	8°·40		ζ	277°·82
	κ	150°·78		H	0·063		H	0·042		H	0·111
	ζ	=		κ	197°·15		κ	57°·16		κ	173°·75
S_2	H	1·349	M_8	R	0·046	L_2	R	0·326	$(MS)_4$	R	0·707
	R	=		ζ	6°·88		ζ	73°·21		ζ	91°·16
	κ	149°·26		H	0·040		H	0·320		H	0·685
	ζ	=		κ	135°·54		κ	136°·71		κ	213°·33
S_4	H	0·062	O_1	R	0·233	N_2	R	0·673	$(2SM)_2$	R	0·128
	R	=		ζ	252°·64		ζ	102°·06		ζ	160°·96
	κ	227°·80		H	0·275		H	0·654		H	0·123
	ζ	=		κ	51°·33		κ	96°·13		κ	38°·79
S_6	H	0·005	K_1	R	0·355	λ_2	R	0·107	$2N_2$	R	0·123
	R	=		ζ	166°·69		ζ	55°·83		ζ	216°·87
	κ	261·42		H	0·425		H	0·104		H	0·120
	ζ	=		κ	41°·17		κ	106°·79		κ	79°·06
S_6	H	0·002	K_2	R	0·291	ν_2	R	0·179	$(M_2N)_4$	R	0·134
	R	=		ζ	103°·20		ζ	113°·46		ζ	275°·26
	ζ	319·76		H	0·371		H	0·173		H	0·126
M_1	R	0·039		κ	163°·78		κ	125°·65		κ	30°·32
	ζ	=	P_1	R	0·119	μ_2	R	0·369	$(M_2K_1)_3$	R	0·184
	H	328°·51		ζ	349°·02		ζ	29°·79		ζ	36°·14
	κ	0·029		H	0·119		H	0·347		H	0·167
	ζ	=		κ	54°·02		κ	275°·02		κ	92°·73
M_2	R	33°·39	J_1	R	0·019	R_2	R	0·133	$2M_2K_1)_3$	R	0·107
	ζ	351°·08		ζ	356°·71		ζ	154°·09		ζ	125°·81
	H	3·720		H	0·022		H	0·133		H	0·111
	κ	113°·24		κ	22°·11		κ	78°·07		κ	69°·66
M_3	R	0·021									
	ζ	161°·30									
	H	0·020									
	κ	164°·54									
M_4	R	0·056									
	ζ	286°·76									
	H	0·069									
	κ	271°·06									

Long-period Tides.

	R	ζ	H	κ
Lunar monthly tide	0·452	248°·73	0·467	18°·72
,, fortnightly ,, ...	0·261	104·60	0·377	49·27
Luni-solar ,, ,, ...	1·126	167·40	1·091	45·23
Solar annual ,, ...	2·519	126·35	2·519	151·86
semi-annual ,, ...	0·663	248·35	0·653	296·36

The value of (A_0) the mean level of the sea at Moulmein for 1883-84 is 8·737 feet, and is higher than the value obtained for any of the three previous years; the lowest value is that obtained in 1880-81, viz. 8,453 feet, or nearly 3½ inches lower than the value for the present year.

The value of the mean amplitude (II) of the main lunar tide (M_2) is 3,720 feet; the fluctuation in the values of this component is not very great at Moulmein, considering the magnitude of the amplitude.

The main solar tide (S_2) has an amplitude of 1·349 feet, which is almost precisely the same as the values for the two former years, and differs from the 1880-81 value by a little more than half an inch.

The next largest semi-diurnal tide (N_2) agrees fairly well in its amplitude as compared with the two former years, and it is also less than the 1880-81 value. But the smaller lunar elliptic tide (L_2) has a considerable fluctuation in the values of its amplitude.

The proportion of the main solar to the main lunar tide is 0·363: this is slightly nearer the theoretical proportion (0·465) than we obtained from former observations.

The lunar elliptic tides (L_2) and (N_2) are 0·086 and 0·176 of the main tide: the latter value is very nearly the theoretical proportion, and this agrees with former years, but the proportion for the former component is three times as great as it ought to be, which is the same as the 1881-82 value, but the value for the two other years of observation was a good deal less.

The smaller evectional tide (λ_2) is theoretically insignificant; at Moulmein it appears to be from 3 to 7 per cent. of the main tide.

The larger component (ν_2) is 0·047 of the main lunar tide; theoretically it ought to be 0·038, but the values in former years ranged from 0·045 to 0·081

The diurnal tides at Moulmein in proportion to the main tide and compared with the theoretical values are as follow:—

	Moulmein, 1883-84.	Theoretical.
Luni-solar K_1	0·114	0·584
Lunar M_1	·005	·036
Solar declinational P_1	·032	·193
Lunar ditto O_1	·074	·445
Do. elliptic J_1	·006	·033
Solar ditto Q_1	·011	·080

Thus it will be seen that all the diurnal tides are exceedingly small in comparison to their theoretical proportions, the largest (K_1) being only 1/5 per cent. instead of 58 per cent. of the main tide.

Regarding the over-tides, the lunar quarter-diurnal is very large, being 23 per cent. of the main tide. This agrees very closely with the three former values; the other over-tides which are significant, appear to be (M_6) and (S_6) which are 0·025 and 0·017 respectively of the main tide.

The luni-solar quarter-diurnal $(M\,S)_4$ is 18 per cent. of the main tide.

The compound tides $(M_2, K_1)_3$, $(2M_2\,K_1)_5$, and $(M\,N)_4$ have this year been calculated as well as the compound tide $(2SM)_4$, and have values 0·034, 0·053, 0·030 respectively in their proportion to the main tide; the amplitude of $(2SM)_4$ as compared with that of the main tide is 0·033 which is quite in accordance with the three former values.

With reference to the long-period tides, the most remarkable is the luni-solar fortnightly, which is 29 per cent. of the main tide, and this is almost precisely the same value as was obtained in each of the three preceding years. Its epoch too is remarkably accordant, the greatest discrepancy in any two years being only five degrees, or about five hours in time.

But the long-period tide which has the greatest magnitude is the solar annual, which this year is 68 per cent. of the main tide, and agrees very well with the three former values: its time of maximum occurs about the 20th August: the tide is evidently meteorological and caused by freshets in the river.

The solar semi-annual tide is 18 per cent. of the main tide. This agrees fairly well with the three former values.

The lunar monthly tide appears to be about 11 per cent. of the main tide, but its value is somewhat variable.

The lunar fortnightly tide is this year 10 per cent. of the main tide; in the three former years it varied from 7 to 9 per cent.

Extract from the Narrative Report by MAJOR W. J. HEAVISIDE, R.E., *Officiating Deputy Superintendent, 2nd grade, in charge of Nos. 1 and 2 Astronomical Parties, Survey of India, for season* 1883-84.

THE two parties left Mussooree about the 31st of October 1883, and had assembled in Calcutta by the 5th of November. Eleven days were occupied there in testing the instruments and taking observations for personal equation. On the 16th I embarked for Akyab, leaving Major Strahan in Calcutta.

The table below exhibits the programme drawn up in recess quarters with the probable dates as estimated for the completion of the work, and also what was actually accomplished during the field season :—

Number of Arc in succession.	Observers and stations.	Estimated date for completion of the Arc.	Actual dates.		Number of nights on which observations were taken.
			Commenced.	Completed.	
28	Major Heaviside at Akyab ... ... „ Strahan at Calcutta	4th December	27th November	14th December	8
29	„ Heaviside at Akyab ... ... „ Strahan at Chittagong	16th „	26th December	4th January	8
30	„ Heaviside at Promo ... ... „ Strahan at Chittagong	16th January	21st January	30th „	8
31	„ Heaviside at Promo ... ... „ Strahan at Akyab	27th „	8th February	13th February	4
32	„ Strahan at Moulmein ... ... „ Heaviside at Promo	13th February	8th March	15th March	
33	„ Strahan at Moulmein ... ... „ Heaviside at Akyab	4st March	26th „	3st April	7
	Personal equation before and after the measurement of the arcs	.....	November 8th, 9th, 13th, 14th; April 26th, 28th		
	An azimuth by Major Strahan at the Great Trigonometrical Survey Station of Tourgrún, near Moulmein	.....	March 18th to 22nd		6
	Independent observations for pivot errors				
	By Major Strahan	.....	January 26th, 27th; February 11th, 16th, 17th, 18th.		6
	„ „ Heaviside	.....	November 25th; December 17th, 20th, and 21st; January 6th, 9th; February 3rd, 4th, 23rd, 24th.		9

On the 23rd of November I was ready at Akyab to commence observing, but owing to the Penang-Madras cable being out of order the messages to India and to Europe from China and the Straits were all thrown on to the main lines through Burma, and the line could not in consequence be spared for our work until the 27th of November. On the 28th very stormy weather set in, winding up with a cyclone near Chittagong, and preventing any further observations until the 8th December, after which we made most satisfactory progress with the first arc. The second and third arcs were carried on without any delays other than arose from two or three cloudy nights and the time necessary for one officer to move by sea from one station to the next; but on the fourth arc we were met by some more cloudy weather, and on the 15th of February the Penang-Madras cable again broke down, and the Burma main lines became so choked with traffic that no concession of the line was possible, although Major Strahan arranged a programme of work by which we should have required the line only for periods of five minutes three times during the night, and offered to pay for its use.

We waited on until the 29th, but finding the line still blocked with business, and the cable, though repaired, in a delicate condition, we agreed to be content with what had been done on the fourth arc, and that Major Strahan should move on to Moulmein and take up the fifth arc, which was not on the main line of traffic. The fifth arc was finished in eight nights; we then had to return to the main line for the sixth arc, and after completing seven nights' work the cable again broke down and the line could not be spared: after waiting on for some days we decided to close the season. Major Strahan left Moulmein on the 8th and I left Akyab on the 9th of April, and we both reached Calcutta on the 14th of that month. At that time I was suffering from a severe attack of fever, but was sufficiently recovered to observe for personal equation by the 26th of April. On the 29th I took over charge of No. 2 Astronomical Party from Major Strahan, who proceeded on furlough, and both parties moved up to Mussooree, where recess duties were commenced on the 8th of May.

In the original programme it was considered that six nights of observations would suffice for each arc, but subsequently, on Mr. Hennessey's visit to Calcutta in November 1883, it was resolved, in consultation with Major Strahan, to increase the number of nights on each arc to eight, not with a view to greater accuracy in the final value of ΔL for each arc, but for the better determination of some instrumental errors, which will be more fully considered later on. This arrangement was again modified at my suggestion to six or eight nights, according to the arrival of the weekly steamers by which we moved, as it was most desirable that the six arcs should be completed this season before the monsoon weather set in, and a method was pointed out by which the instrumental errors of which we were in search could be determined independently by each observer, while the other observer was moving from place to place.

The delays we were obliged to put up with this season were abnormal.

(*a*) We had anticipated more cloudy weather in a moist country like Burma than is usually met with in India, but the weather reports of averages did not lead us to anticipate nearly so much as we encountered.

(*b*) We had to move from station to station by weekly steamers which did not always arrive or depart on the advertised day; on three occasions we were unable to complete the observations in time to catch the steamers and had to wait six, and on one occasion nine days for the next vessel.

(*c*) The Penang-Madras cable broke down on three occasions, so that we were unable to obtain the use of the telegraph line for periods of some days, and the cable was in weak condition during the greater part of the season, so that considering all things I cannot but think we were fortunate in being able to complete our programme with but one rather weak link, viz. Arc No. 30, which is dependent on only four nights' observations.

The delays were, however, not thrown away, as they gave time for independent investigations of supposed instrumental errors, the result of which was a determination at the close of the field season to send the telescopes to England to the makers, Messrs. Cooke and Sons, for repair.

A considerable advance was also made in the field towards the reduction of the observations.

The health of the parties was on the whole good; one of the recently engaged khalasies died of anæmia, which he had apparently contracted before he joined the department.

The pillars for the instruments having been built, and the connexion of the longitude stations with the triangulation carried out by Mr. Keelan last year, the services of Mr. D. Atkinson were not required in Burma, and he remained at Dehra throughout the field season, employed in reading off the chronograph sheets as they were sent to him and reducing the observations.

In the general report for 1882-83, at pages 53 to 58, Mr. J. B. N. Hennessey investigated the results and the circuit and residual instrumental errors obtained from the observations of 1875 to 1883, and in paragraph 260 he stated that a system would be adopted in the observations of 1883-84 by which the residuals for each telescope might be determined and the facial difference removed.

It is here proposed to give a short account of the system of observation pursued, with the results and the conclusions to which they have led.

The system of observation was by similar and dissimilar pivots, so that if the first night's work for the measurement of any one arc of longitude was undertaken with the illuminated pivots of both telescopes east (symbolically I P.E.), the second night's work was carried out with one telescope I P. E. the other I P. W.; the third night with both telescopes I P. W.; the fourth with one I P. W. the other I P. E.; and on the fifth night in positions similar to what they were on the first night.

The east station as usual always took the initiative in changing, so that the positions were—

	At West Station.	At East Station.
First night	... I. P. E.	I. P. E.
Second „	... I. P. E.	I. P. W.
Third „	... I. P. W.	I. P. W.
Fourth „	... I. P. W.	I. P. E.
Fifth „	... I. P. E.	I. P. E.

and so on in regular succession.

It will be seen that on this system it requires four nights to complete the several instrumental combinations, and consequently the usual six nights' observations which were in former seasons considered sufficient to ensure a good final result were extended to eight nights, though owing to circumstances previously mentioned eight nights could not always be adhered to.

On the arcs 27 and 28 two systems of observation were adopted, one being that known as "observations of transits at both stations with the same clocks," the other "observations of transits with local clocks combined by clock comparisons," thus giving two results for each night for each position of the telescopes; and throughout these two arcs the telescope at the west station remained in position for the first two successive nights, while the other telescope was reversed, and then the telescope at the east station remained in position for two nights, while the other was reversed.

On the last four arcs the procedure was altered; observations were taken only "with the same clocks" and the position of the telescope at the east station was reversed from I. P. E. to I. P. W., or *vice versâ*, half way through each night's observations, while the telescope at the west station was reversed between each two nights of observation. Thus for eight nights' work there would be sixteen different values, four for each combination of instrumental position.

This will be more fully understood by a reference to Table I.

It must be understood that this paper is based on the supposed existence of constant error following change of pivots; inconstant errors due to actual shakiness in the instruments, or to personal peculiarities in the observers, are beyond the bounds of this investigation.

ΔL stands for the measured value of an arc:—

$\overline{\Delta L}$ its true value, which is unattainable:

e its accidental errors of observation, which are unattainable; and the instrumental disposition primarily provided for is—

No. 1 Telescope at the west station of the arc ... ... (1)
„ 2 „ „ east „ „ ... ... (2)

and the right and left hand subscripts will invariably represent the telescopes and their instrumental position at the east or west station respectively; for instance—

$$\underset{E_1\ W_2}{\Delta L} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

means that the measure of longitude was taken with No. 2 telescope at the east station and its illuminated pivot west; while No. 1 telescope was at the west station with its illuminated pivot east.

Again, it is assumed that with I. P. E. the effect of the residual in either instrument is to cause the telescope to describe an arc west of the meridian, and consequently to give a *positive* error in time of transit, and therefore with I. P. W. to give a *negative* error.

Let x_1, x_2 stand for the errors or instrumental residuals of No. 1 and No. 2 telescope respectively.*

Then for the four pivot combinations adopted this season we have—

$$\underset{E_1\ E_2}{\Delta L} = \left\{ \overline{\Delta L} + \underset{E\ E}{e} \right\} + (x_1 - x_2) \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

$$\underset{W_1\ W_2}{\Delta L} = \left\{ \overline{\Delta L} + \underset{W\ W}{e} \right\} - (x_1 - x_2) \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

$$\underset{E_1\ W_2}{\Delta L} = \left\{ \overline{\Delta L} + \underset{E\ W}{e} \right\} + (x_1 + x_2) \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

$$\underset{W_1\ E_2}{\Delta L} = \left\{ \overline{\Delta L} + \underset{W\ E}{e} \right\} - (x_1 + x_2) \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

Or if the instruments be transposed, No. 1 telescope being at the east station and No. 2 at the west station,—

$$\text{Then } \underset{E_2\ E_1}{\Delta L} = \left\{ \overline{\Delta L} + \underset{E\ E}{e} \right\} - (x_1 - x_2) \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

$$\underset{W_2\ W_1}{\Delta L} = \left\{ \overline{\Delta L} + \underset{W\ W}{e} \right\} + (x_1 - x_2) \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

$$\underset{E_2\ W_1}{\Delta L} = \left\{ \overline{\Delta L} + \underset{E\ W}{e} \right\} + (x_1 + x_2) \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

$$\underset{W_2\ E_1}{\Delta L} = \left\{ \overline{\Delta L} + \underset{W\ E}{e} \right\} - (x_1 + x_2) \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

Assuming, as we are bound to do, that the quantities within brackets thus $\left\{ \right\}$ eliminate in differences, then from (3) and (4) or from (7) and (8) we obtain $(x_1 - x_2)$; and from (5) and (6) or from (9) and (10) we obtain $(x_1 + x_2)$; and hence x_1 and x_2.

In Table I the observed values of ΔL corrected for personal equation are given for each instrumental position followed by the values of x_1 and x_2 deduced as explained above, and finally the values of ΔL corrected by the mean values of the quantities x_1 and x_2 obtained for each arc. It will be seen that after these corrections the mean results are brought into much closer agreement, showing, it is considered, that a residual of the character supposed does exist.

Table II exhibits the circuit errors. The quantities in columns 5 to 7 (abstracted from Table I) are the means in the various instrumental positions corrected by the residuals x_1, x_2.

The mean by EE and WW should in each case agree with that by EW and WE, and the results tend to show that the values EE, WW for arc 31 form a weak link. Unfortunately, owing to the telegraph line not being available, as stated above, this arc is dependent on four instead of eight nights' observations.

It has been previously stated that each observer took observations independently for the determination of the residual instrumental errors x_1 and x_2. The method adopted was to observe about 20 stars on one night with the telescope in one position, say, I. P. E. and on any subsequent night to observe the same stars one-half with the telescope I. P. E., the other half with the telescope I. P. W. Then presuming that the clock rate does not vary during the time the observations are being taken, that is during about one hour on each night, the mean rate obtained from the first ten stars should be the same as the mean by the last ten, and half the difference between the two means will give x_1 with telescope No. 1, or x_2 with telescope No. 2. Occasionally 30 stars were observed, and the instrument was reversed twice on the second night, the positions being, say, I.P.E., I.P.W., I.P.E. The results obtained are given in Table III.

* In the General Report for 1882-83, page 54, x_1, x_2 were assumed to be the errors of the telescopes with I. P. E. and $-y_1$, $-y_2$ with I. P. W.; but x_1, x_2 are now assumed equal to y_1, y_2 respectively.

A certain number of zenith stars were, as is usual, observed independently every night under both aspects during the progress of the work on each arc, the procedure adopted being to observe the zenith star over the first ten wires, the observer facing north or south; he then moved round the telescope, and observed the same star over the last ten wires with his face in the opposite direction. The difference between the mean of the times reduced to the centre wire under each aspect was deduced, and the mean at each station of all these differences will be found in Table IV, and is the quantity which when applied to the time by a star of south aspect will make it comparable with the time by the same star observed under a north aspect. It is scarcely necessary to state that about an equal number of observations were taken commencing with each aspect, and that the telescope was as often in position I. P.E. as I. P.W.

It was pointed out last year that each observer had a regular tendency to intersect a star sooner over the last wires than over the first wires, irrespective of the star's aspect. This personal equation termed the (1st—2nd) equation has been derived from the same zenith stars as the (N—S) equation. The mean results are given in Table IV for each observer, and are the quantities that require to be applied to the time deduced from a star over the last ten wires to make it accord with the time of the same star over the first ten wires. This equation has been eliminated from the results of the (N—S) equation. It will be seen that Major Strahan's (1st—2nd) equation has the opposite sign to Major Heaviside's, and shows that the former anticipates the transits over the first wires and the latter over the last wires.

For 1882·83 these equations were—

$$S_1 - S_2 = +0^s{\cdot}040$$

$$H_1 - H_2 = +0{\cdot}051$$

Table V exhibits the results obtained when both observers were together and could observe the same stars with the same telescope, one observer taking a star over the first ten wires, the other over the last ten wires, then changing the order of observation for the next star, and so on alternately.

Table VII exhibits the probable error of the observation of one wire and of the mean of all the wires over which a star was observed. Two nights on each arc, when the work was not interrupted by clouds, were taken at random, and for each night and each observer three slow and three quick moving stars were selected, giving 12 values for each observer on each arc, the means of which are given in Table VII. On the first two arcs each star was observed over 15 wires, but for subsequent arcs over only 10 or 11 wires. This alteration was made at the risk of increasing the probable errors with the hope that the (1st—2nd) equation might then disappear. It will be seen by Table VII that the reduction in the number of wires observed did not increase the probable errors, nor had it the effect of reducing the (1st—2nd) equation as is shown in Table VI.

To form Table VI, two nights when there were no clouds were chosen for each station of each arc, and for the first two arcs when each star was observed over 15 wires, the difference between the mean of the times by the first five and last five wires were taken out for every star observed, and on the last four arcs when the stars were observed over only 10 or 11 wires, the difference between the first three and last three wires were abstracted. The mean of all the differences for the two nights by each observer are given in Table VI and represent the quantities which applied to the mean of the times by the last five wires in the case of the first two arcs, or to the mean of the times by the last three wires in the case of the last four arcs, will make those times comparable with the times by the first five, and first three wires respectively.

TABLE I.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS, 1883-84.

Abstract of Values of ΔL *in the various instrumental positions.*

* Name and symbolical number of arc.	Observed values of ΔL corrected for Personal Equation.										Deduced values of residual instrumental error.		Values of ΔL corrected for residual instrumental error.			
	Hour and minute.	Astronomical date of observation.	Seconds of arc for position E.W.	Astronomical date of observation.	Seconds of arc for position W.W.	Astronomical date of observation.	Seconds of arc for position E.W.	Astronomical date of observation.	Seconds of arc for position W.E.		x_1.	x_2.	For position E.E.	For position W.W.	For position E.W.	For position W.E.
Akyab. Calcutta. $\left(\frac{28}{2\ 1}\right)$	H. M.	1883.	Sec.		Sec.		Sec.		Sec.				Sec.	Sec.	Sec.	Sec.
		Nov. 27th ...	9·542	Dec. 9th ...	9·025	Dec. 8th ...	9·416	Dec. 10th ...	9·190		−0·035	+0·163	9·311	9·289	9·347	9·259
		,, ,, ...	·629	,, ,, ...	·135	,, ,, ...	·456	,, ,, ...	·188		·104	·132	·398	·364	·357	·257
	0 18	Dec. 11th ...	·573	13th ...	·101	,, 12th ...	·447	,, 14th ...	·201		·057	·191	·341	·332	·373	·469
		,, ,, ...	·558	,, ,, ...	·129	,, ,, ...	·429	,, ,, ...	·426		·107	·108	·327	·300	·360	·495
		Means ...	9·575	.....	9·116	.....	9·437	.....	9·299		−0·031	+0·160	9·344	9·347	9·368	9·368
								General mean ...	9·357						General mean	9·357
Akyab. Chittagong. $\left(\frac{29}{2\ 1}\right)$		Dec. 26th ...	14·466	Dec. 28th ...	14·024	Dec. 27th...	14·218	Dec. 29th...	13·926		−0·033	+0·184	14·245	14·245	14·177	14·167
		,, ,, ...	·592	,, ,, ...	14·054	,, ,, ...	·354	,, ,, ...	·959		·040	·175	·261	·275	·213	·200
	0 4	,, 30th ...	·363	Jan. 3rd ...	13·934	Jan. 2nd...	·302	Jan. 4th...	·033		·058	·186	·142	·155	·161	·174
		,, ,, ...	·367	,, ,, ...	·917	,, ,, ...	·283	,, ,, ...	·018		·045	·190	·146	·138	·147	·159
		Means ...	14·425	.....	13·952	.....	14·316	.....	13·984		−0·040	+0·181	14·206	14·203	14·175	14·175
								General mean ...	14·159						General mean	14·159
Promo Chittagong. $\left(\frac{30}{2\ 1}\right)$		1884.														
		Jan. 22nd ...	34·675	Jan. 21st ...	30·907	Jan. 22nd...	30·559	Jan. 21st ...	30·492		−0·063	+0·142	30·510	30·432	30·488	30·473
		,, 24th ...	·676	,, 23rd ...	·880	,, 24th...	·551	,, 23rd...	·536		·021	·098	·511	·046	·459	·469
	0 13	,, 26th ...	·745	,, 25th ...	·852	,, 26th...	·469	,, 25th...	·541		·042	·105	·550	·617	·398	·412
		,, 30th ...	·696	,, 29th ...	·320	,, 30th...	·543	,, 29th...	·413		·061	·128	·533	·485	·477	·484
		Means ...	30·690	.....	30·360	.....	30·532	.....	30·382		−0·047	+0·118	30·551	30·395	30·461	30·459
								General mean ...	30·497						General mean	30·497
Promo Akyab. $\left(\frac{31}{2\ 1}\right)$		Feb. 8th ...	16·346	Feb. 9th ...	16·056	Feb. 8th...	16·412	Feb. 9th...	16·195		−0·023	+0·132	16·202	16·180	16·164	16·243
	0 9	,, 12th ...	·357	,, 13th ...	·089	,, 12th...	·152	,, 13th...	·211		·074	·060	·213	·233	·134	·259
		Means ...	16·352	.....	16·092	.....	16·297	.....	16·203		−0·048	+0·096	16·207	16·207	16·149	16·251
								General mean ...	16·229						General mean	16·229
Moulmein Promo. $\left(\frac{32}{1\ 2}\right)$	H. M.	1884.		1884.		1884.		1884.								
	0 9	March 10th ...	38·343	March 9th ...	38·773	March 10th	38·639	March 8th	38·679		−0·003	+0·046	38·694	38·718	38·612	38·706
		,, 12th ...	·093	,, 11th ...	·757	,, 12th	·740	,, 11th	·633		·011	·063	·664	·626	·712	·660
		,, 14th ...	·686	,, 13th ...	·588	,, 14th	·690	,, 13th	·576		+ ·053	·004	·747	·527	·663	·603
		(·611)	(·611)	,, 15th ...	·908		(·690)	,, 15th	·555		− ·041	·068	(·672)	·747	(·663)	·632
			38·611	.....	38·732	.....	38·690	.....	38·636		−0·017	+0·044	38·673	38·673	38·663	38·663
								General mean ...	38·667						General mean	38·667
Moulmein Akyab. $\left(\frac{33}{1\ 2}\right)$		March 26th ...	54·897	March 27th ...	54·895	.....		March 27th	54·912		−0·020	+0·026	54·904	54·921	(54·923)	54·913
		,, 28th ...	·812	,, 29th ...	55·012	March 28th	54·911	,, 29th	·944		·068	·040	·879	·975	·910	·945
	0 18	,, 30th ...	·863	,, 31st ...	·016	,, 30th	·977	,, 31st	·911		+ ·003	·039	55·039	·940	·976	·912
		April 1st ...	·847	.....	(55·015)	April 1st	·884	.....	(·922)		− ·031	·032	·914	(·948)	·883	(·923)
			54·880	.....	55·015	.....	54·924	.....	54·922		−0·033	+0·034	54·947	54·948	54·923	54·923
								General mean ...	54·935						General mean	54·935

* Where the *name* of an arc is entered, it has invariably been the practice to place the east station *first* and the west station *second*, while in the *symbolical number* of the arc the subscripts are written left or right according as the instruments to which they refer were at the west or east station.

Explanation of the table :—

In column 1.—The name of the arc is given with its symbolical number: the right and left hand subscripts represent the number of the telescope at the east and west station, respectively.

In column 2.—The amplitude of the arc in hours and minutes is given.

In columns 3, 5, 7, 9.—The dates of observation are given.

In columns 4, 6, 8, 10.—The deduced values of Δ L corrected for Personal Equation are given for each instrumental combination.
The letters E.W., &c., in the headings notify the direction of the pivots of the telescopes, the right and left hand letters referring to the telescope at the east and west station, respectively. In the first two arcs there are two values for each position for each date, due to two systems of observation as previously explained.

In columns 11, 12.—The deduced values x_1, x_2, of the residuals for telescopes Nos. 1 and 2 respectively are given, the negative or positive sign showing that with illuminated pivot east that telescope traces out an arc east or west respectively of the true meridian.

In columns 13 to 16.—The values of Δ L corrected for the residuals x_1, x_2 are given, and below, the general means for each are before and after the application of these residuals.
The quantities in brackets were not observed, but are the means of three other quantities in the same column, and are introduced to give equal weight to the observations in the different instrumental positions.

Table II.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS.

Circuit errors for different Instrumental Positions, 1883-84.

Position.	Symbolical.			Numerical.			Circuit error.	Mean circuit error.
	+	−	−	+	−	−		
				h m s 0 — 18	h m s 0 — 4	h m s 0 — 9		
				sec.	sec.	sec.		
EE	$(^{30}_{2\ 1})$	$(^{29}_{2\ 1})$	$(^{31}_{2\ 1})$	30·534	14·204	16·207		
WW				·535	·203	16·207	+	
			Means ...	30·535	14·204	16·207	0·124	
EW				30·461	14·175	16·249		·08
WE				·459	·175	·251		
			Means ...	30·460	14·175	16·250	0·035	
				h m s 0 — 18	h m s 0 — 9	h m s 0 — 9		
				sec.	sec.	sec.		
EE	$(^{33}_{1\ 2})$	$(^{31}_{2\ 1})$	$(^{32}_{1\ 2})$	54·947	16·207	38·672		
WW				·948	16·207	38·671		
			Means ...	54·948	16·207	38·671	0·070	
EW				54·923	16·249	38·663		0·04
WE				54·923	·251	38·663		
			Means ...	54·923	16·250	38·663	0·010	
				h m s 0 — 18	h m s 0 — 13	h m s 0 — 4		
				sec.	sec.	sec.		
EE	$(^{23}_{2\ 1})$	$(^{24}_{2\ 1})$	$(^{29}_{2\ 1})$	9·344	55·263	14·204		
WW				·347	54·969	·203		
			Means ...	9·346	55·119	14·203	0·024	
EW				9·368		14·175		
WE				·368	Not observed.	·175		
			Means ...	9·368		14,175		

Table III.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS.

Results of Observations taken independently for the Determination of the Residuals x_1, x_2.

Observer and Telescope.	Stations of observations.	Dates of observation.	Deduced values of the residuals	
			x_1	x_2
Major Strahan	Chittagong	January 26th to 27th	.....	+0·115
Telescope No. 2	Akyab	February 11th to 12th	.....	·180
	Ditto	Ditto 16th to 17th	.....	·154
	Ditto	Ditto 17th to 18th	.....	·111
		Mean	.....	+0·140
Major Heaviside	Akyab	December 17th to 20th ...		−0·019
Telescope No. 1	Ditto	Ditto 20th to 21st ...		·036
	Ditto	Ditto 21st to January 6th ...		·046
	Ditto	January 6th to 7th ...		·004
	Prome	February 3rd to 4th ...		·020
	Ditto	Ditto 23rd to 24th ...		+·004
	Ditto	Ditto 24th to March 7th ...		·043
		Mean ...		−0·011

Table IV.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS, 1883-84.

Results of the absolute (*N*—*S*) *Equation and of the* (1*st*—2*nd*) *Equation deduced from the same Zenith Stars.*

Station of observation.	Mean date of observation.	Deduced Equations.			Station of observation.	Mean date of observation.	Deduced Equations.		
		$S-S_{N\ S}$	$S-S_{1\ 2}$	Number of measures.			$H-H_{N\ S}$	$H-H_{1\ 2}$	Number of measures.
	1883.	s.	s.			1883.	s.	s.	
Calcutta ...	11th December ...	+0·030	−0·052	55	Akyab ...	11th December ...	+0·014	+0·024	44
Chittagong ...	31st ,, ...	−0·009	−0·059	55	Do. ...	31st ,, ...	+0·050	+0·032	45
	1884.					1884.			
Chittagong ...	26th January ...	−0·007	−0·055	32	Prome ...	26th January ...	+0·020	+0·043	47
Akyab ...	11th February ...	−0·017	−0·049	23	Do. ...	11th February. ...	+0·020	+0·031	23
Moulmein ...	12th March ...	+0·021	−0·059	30	Do. ...	12th March ...	+0·024	+0·023	39
Ditto ...	29th ,, ...	−0·001	−0·059	21	Akyab ...	29th ,, ...	+0·036	+0·028	27

TABLE V.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS, 1883-84.

Results of Relative Personal Equation.

Date of observation.	Number of stars observed under each aspect.	RELATIVE PERSONAL EQUATION. $S_N - H_N$.	RELATIVE PERSONAL EQUATION. $S_S - H_S$.
1883.		s s	s s
8th November	22 north : 18 south	+0·034 ±0·011	+0·017 ±0·010
9th ,, ...	20 ,, 21 ,, ...	+0·009 ±0·007	+0·020 ±0·009
13th ,, ...	10 ,, 10 ,, ...	−0·038 ±0·012	+0·064 ±0·012
14th ,, ...	12 ,, 13 ,, ...	−0·019 ±0·023	+0·005 ±0·014
1884.			
26th April	17 ,, 17 ,, ...	−0·017 ±0·010	+0·034 ±0·008
28th ,, ...	12 ,, 13 ,, ...	−0·024 ±0·012	+0·050 ±0·007

TABLE VI.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS.

Abstract of Results of the (1st—2nd) Equation as deduced from transits of stars used in the determination of ΔL, 1883-84.

Arc.	Date.	Number of wires over which each star was observed.	RESULTING (1ST—2ND) EQUATION. Major Strahan $S_1 - S_2$.	Number of measures from which deduced.	Major Heaviside $H_1 - H_2$.	Number of measures from which deduced.
			s		s	
Akyab—Calcutta	Dec. 8th and 14th ...	15	+0·005	52	+0·029	54
Akyab—Chittagong	,, 24th and Jan. 4th	15	·009	55	·018	57
Prome—Chittagong	Jan. 23rd and 30th ...	10	·015	88	·029	84
Prome—Akyab	Feb. 8th and 13th ...	10	·017	81	·015	77
Moulmein—Prome	Mar. 11th and 18th ...	11	·045	79	·028	81
Moulmein—Akyab	,, 29th and Apl. 1st	11	·025	78	·017	78

TABLE VII.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS.

Probable errors of the Transit Observations, 1883-84.

Arc.	Number of wires over which each star was observed.	MAJOR STRAHAN. Probable error of: Mean of all the wires.	MAJOR STRAHAN. Probable error of: One wire.	MAJOR HEAVISID. Probable error of: Mean of all the wires.	MAJOR HEAVISID. Probable error of: One wire.
		s	s	s	s
Akyab—Calcutta	15	±0·0123	±0·0408	±0·0118	±0·0457
Akyab—Chittagong	15	±0·0143	±0·0397	±0·0112	±0·0438
Prome—Chittagong	10	±0·0 13	±0·0544	±0·0104	±0·0329
Prome—Akyab	10	±0·0123	±0·0390	±0·0119	±0·0380
Moulmein—Prome	11	±0·0117	±0·0386	±0·0096	±0·0319
Moulmein—Akyab	11	±0·0099	±0·0333	±0·0102	±0·0338

NOTE.—The capitals in the headings of the columns in Tables IV, V, VI stand for the observer's initials: S for Major Strahan; H for Major Heaviside. The subscripts N, S denote the aspects under which the star was observed, and the subscripts 1, 2, denote the order in which certain wires were observed.

Summary of the outturn of Field Work of the Parties of the Survey

Scale of survey.	Name and *locale* of Field operations.	Instruments used.	Area triangulated in square miles.	Number of stations at which observations were taken.	Number of square miles to each point trigonometrically fixed.	Number of square miles to each height.	TRIANGULATION. 2nd class triangulation, in which each angle is usually observed on two zeros. Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	3rd class or tertiary triangulation, in which two angles of each triangle are observed. Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.	Number of extra heights determined.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
32″ = 1 mile ...	Benares and Basti districts	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	1
16″ = 1 mile ...	Ajmere-Merwara district ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Bassein and Henzada districts	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Benares and Basti do.	.....	.....	...	...	...	...		.....	.....	...	...	...	.....	...	...	
	Chhattisgarh division ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	5
	Dehra Dún district ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Gorakhpur do. ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Kamrup do. ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Pegu and Shwegyin districts	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Prome and Akyab do.	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	10
12″ = 1 mile ...	Hissar district	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Mysore	6″, 8″, 12″	57	28	0·3	0·3	23	34	4″	0·2	22	150	333	1·0	157	...	
	Rajputana	12″, 14″	97	45	0·2	0·2	40	136	4·3	0·3	23	379	688	0·4	67	...	
6″ = 1 mile ...	Andaman	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Darjeeling	6″, 7″, 10″, 12″	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	15
6″ = 1 mile ...	Hissar district	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
4″ = 1 mile ...	Aligarh and Etah districts...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Andaman	6″, 7″, clinometer.	323	21	3·6	5·3	15	40	6·7	0·3	17	80	127	1·9	57	41	
	Burma forests	5″, 7″	450	28	15	15	8	10	17	0·4	8	21	38	0·9	21	117	
	Gorakhpur district	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	20
	Guzerat	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Thana district	.....	680	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
2″ = 1 mile ...	Aligarh and Etah districts	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Andaman	7″	600	10	21	84	1	3	5·7	0·4	1	27	40	3·3	7	...	
	Baluchistan	5,″ 6″, 7″	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	25
	Burma	5″, 7″	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Cutch	5½″, 10″	2,100	82	3·0	3·5	74	152	7·9	0·4	70	721	1,101	0·5	529	...	
	Guzerat	6″, 7″	2,199	111	3·4	5·8	86	233	12·7	.....	56	563	512	0·6	500	633	
	Hissar	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Mirzapur	12″	344	23	3·1	4·4	18	44	5·9	0·5	17	87	139	1·3	62	...	30
	Prome and Akyab districts	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Rajputana	7,″ 8,″ 12″, 14″.	4,133	85	...	...	72	146	8·2	0·1	...	...	...	.....	...	...	
	South Deccan	.....	1,445	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Thana district	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
1″ = 1 mile ...	Malwa	5,″ 6″, 10″.	1,330	44	3·2	44	44	97	13·6	0·6	43	340	501	0·8	228	209	35
	Mysore	6,″ 12″, Pris. compass.	1,400	20	7	7	12	35	6·2	0·1	12	181	333	0·8	181	1,025	
	Nepal boundary	6,″ 7,″ 10″, 12″.	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Rajputana	12″, 14″	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
— 2 miles ...	Assam and North-East Frontier.	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Baluchistan	5,″ 6″, 7″	6,100	59	33	54	62	78	8·5	1·0	44	110	186	3·6	58	30	40
	Sikkim and Darjeeling ...	6,″ 7,″ 10″, 12″.	.....	109	...	...	...	...	...	...	...	700	...	.....	...	...	
1″ — 4 miles ...	Assam and North-East Frontier.	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Baluchistan	6″	22,000	55	175	145	51	145	14	2·3	51	75	150	1·8	46	54	
	Kashmir	7″	2,100	15	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Spirit levelling, Burma ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	35
	Ditto, India ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Orissa and Ganjam coast ...	.....	621c	...	...	...	9	17	3·9	.....	33	30	...	.....	...	...	

of India Department during the year 1883-84.

	Spirit Levelling Operations.				Traversing.					Topography.							
	Number of miles levelled over.	Number of permanent bench mark stones embedded.	Number of trigonometrical stations connected with lines of level.	Number of other permanent points fixed as bench marks.	Number of stations at which theodolite was set up.	Linear miles.	Average angular error per station in seconds.	Average error per 1,000 links in links.	Square miles main circuit and boundary survey.	Area completed during the season in square miles.	Average number of plain table fixings per square mile.	Number of linear miles of test line by which the work has been tested.	Number of villages.	Number of fields.	Average size of fields in acres.	Remarks.
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	
1	...	...	...	...	.....	.....	.....	.....	.....	11	.....	.....	44	40,820	0·17	Benares City Survey.
	...	...	...	...	.....	.....	.....	.....	154*a*	.....	.....	.....	...	.....	...	*a* Including 91 square miles of interior traverses.
	...	...	...	...	.....	.....	.....	.....	976	758	.....	1,068	314	723,810	0·41	
5	...	...	...	...	.....	.....	.....	.....	377	723	.....	2,018	1,730	831,945	0·56	
	...	...	...	...	.....	.....	.....	.....	275	231	.....	275	22	40,000	0·72	
	...	...	...	...	.....	.....	.....	.....	356	269	.....	319	279	98,697	0·78	
	...	...	...	...	.....	.....	.....	.....	929	744	.....	1,332	1,583	891,996	0·53	
	...	...	...	...	.....	.....	.....	.....	563	238	.....	556	334	148,433	0·93	
	...	...	...	...	.....	.....	.....	.....	522	553	.....	496	250	241,744	0·36	
10	...	...	...	...	.....	.....	.....	.....	646	406	.....	734	230	642,561	0·23	
	...	...	...	...	.....	.....	.....	.....	.....	4	.....	.....	...	.....	...	Hissar City Survey.
	...	...	...	...	482	66	22	0·6	.....	24	.....	*in situ*	...	.....	...	Mysore City and Bangalore Cantonment Surveys.
	...	...	...	...	.....	10	.....	.....	.....	10	333·2	*in situ*	...	.....	...	Ajmere and Joypore Cities Surveys.
	...	...	...	...	.....	.....	.....	.....	.....	6	14	*in situ*	...	.....	...	
15	...	...	...	...	.....	.....	.....	.....	.....	30	.....	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	64	.....	.....	...	.....	...	Government Cattle Farm Survey.
	...	...	...	...	.....	.....	.....	.....	.....	98	.....	.....	...	.....	...	
	...	...	...	...	1,507	58	.....	.....	.....	28	97	1·3	...	.....	...	
	...	...	...	...	11,508	642	6	5·9	.....	211	216	2·9	...	.....	...	
20	...	...	...	...	.....	.....	.....	.....	.....	49	.....	.....	31	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	452	62·4	425·0	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	612	612	.....	190 also *in situ*.	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	944	1,507	.....	377	...	.....	...	
25	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	4,840	1·0	33	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	53	45	.....	...	.....	...	
	...	...	...	...	819	670	15	3·6	.....	215	6·3	266·5	...	.....	...	
	...	...	...	...	2,115	376	16	2·1	.....	710	23·6	89·4	...	.....	...	
30	...	...	...	...	.....	.....	.....	.....	1,296	1,782	.....	249	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	436	47	8·3 also *in situ*.	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	163	.....	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	129	14·3	*in situ*	...	.....	...	
	...	...	...	...	.....	1,158	.....	.....	925	1,832	.....	169 also *in situ*.	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	258	258	.....	.....	...	.....	...	
35	...	...	...	...	47	7	8	0·3	.....	1,537	10·3	*in situ*	...	.....	...	
	...	...	...	...	2,107	159	13	0·6 & 16·0	.....	3,961	11·8	40·2	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	655	1·7	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	1,213	8·3	*in situ*	...	.....	...	
	...	...	...	...	.....	143	.....	.....	.....	622	0·1	.....	...	.....	...	Aka Military expedition.
40	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	1,650	.....	.....	...	.....	...	Sikkim. *b* Besides numerous points in the Himalayas.
	...	...	...	...	.....	.....	.....	.....	.....	1,934	0·1	.....	...	.....	...	Aka and Bhutan Hills.
	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	Lieutenant Wahab's reconnaissance not included.
	...	...	...	...	.....	.....	.....	.....	.....	2,100	.....	.....	...	.....	...	Kithanganga Valley.
45	169	...	...	269	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	
	423	30	8	231	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	*c* The area triangulated includes 510 square miles of revision and 43 square miles exterior to main series.

Statement showing the cost-rate of work executed by the several Field Parties of the Survey of India Department during the year 1883-84.

NAMES AND *locale* OF FIELD PARTIES.	Cost-rate per square mile.		Cost-rate per square mile for each scale of detail survey in rupees.										Rate in annas.				Total cost of party.	REMARKS.
													Scale 16″ = 1 mile.		Scale 32″ = 1 mile.			
	Triangulation.	Traversing.	½″	¼″	1″	2″	4″	6″	8″	12″	16″	32″	Per acre.	Per field.	Per acre.	Per field.		
													A. P.	A. P.	A. P.	A. P.	Rs.	
Topographical Surveys.																		
Aligarh and Etah districts	18·3		.....	.....	.....	30·7*	49·3*	.....	.....	.....	.....	.....	.....	.....	.....	.....	51,220	(a) Exclusive of Rs. 1,338-7-10 expended on permanent marks.
Andaman	15·5	35·8	.....	.....	.....	.....	178·2	.....	382·3	.....	.....	.....	.....	.....	.....	.....	22,358	(b) Exclusive of Rs. 2,670-3-9 expended on permanent marks; inclusive of Rs. 23,225 on the revision of previous season's maps, and of Rs. 1,135 for Forest survey on the 4-inch scale, area 6 square miles.
Assam and North-East Frontier ...	.....	69·7	12·3	33·2†	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	53,071	
Baluchistan	4·0	.....	4·6	5·5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	84,261	
Cutch	8·1	8·7	.....	2·5	.....	14·0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	55,676	(c) Exclusive of Rs. 11,607 expended on permanent marks.
Guzerat	6·9	11·7	.....	.....	.....	36·4	103·9	.....	.....	.....	.....	.....	.....	.....	.....	.....	92,496	(d) Exclusive of Rs. 4,264 expended on the survey school.
Malwa	16·5	.....	.....	.....	19·0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	48,707	(e) Exclusive of Rs. 1,326-5-2 expended on permanent marks.
Mirzapur	23·1	.....	.....	.....	.....	81·1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60,480	(f) Exclusive of Rs. 6,408-15-3 expended on permanent marks, and of Rs. 7,269-5-11 expended on completion of Mirzapur maps.
Mysore	5·0	61·4	.....	.....	13·3	.....	.....	.....	.....	306·0	.....	.....	.....	.....	.....	.....	79,557	
Rajputana	4·3	.....	.....	.....	12·7	70·1	.....	.....	.....	109·0	.....	.....	.....	.....	.....	.....	50,647	(g) Exclusive of Rs. 3,520-7-2 expended on completing maps of the Hooghly River survey and of Rs. 187-8 expended on permanent marks.
South Deccan	11·0		.....	.....	.....	27·3*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49,964	(h) Exclusive of Rs. 5,085-7-11 expended on permanent marks, and inclusive of Rs. 21,387 expended on revision of present and previous seasons' maps.
Mouzawar and Forest Surveys.																		
Burma Forests	19·4	97·1	.....	.....	.....	57·6	215·3	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,04,287	(i) Exclusive of Rs. 8,026-2-5 expended on permanent marks, Rs. 1,852-6-0 furlough allowance of one assistant, Rs. 1,775 cost of Prome Town Survey on 64-inch scale, and inclusive of Rs. 19,117-3-3 expended on the revision of previous season's maps.
Hissar district	.....	20·1	.....	.....	.....	30·9*	.....	40·7*	.....	492·4*	.....	.....	.....	.....	.....	.....	51,331(a)	
Thana do.	19·0		.....	.....	.....	35·1*	63·5*	.....	.....	.....	.....	.....	.....	.....	.....	.....	48,995	
Cadastral or Field Surveys.																		(1) Boundary and interior skeleton Traverse Survey; very hilly and difficult ground.
Ajmere-Merwara district	.....	82·4(1)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11,466	
Bassein and Henzada districts ...	.....	52·8	.....	.....	.....	.....	.....	.....	.....	.....	250·6*	.....	6 6		4 0		1,97,544(b)	(2) Includes writing of khasras under the Benares system and intricate City Survey.
Benares and Basti ditto	.....	21·9	.....	.....	.....	.....	.....	.....	.....	.....	161·1*	687·7*	4 0 (2)		2 3		1,24,067(c)	(3) Cost-rate of Field Block Survey.
Chhattisgarh division	.....	31·5 70·1(3)	.....	.....	.....	.....	.....	.....	.....	.....	173·3*	.....	4 4 1 9 (5)		.....		21,768(d)	(4) Includes writing of khasras under the Benares system.
Dehra Dún district	.....	37·5	.....	.....	.....	.....	.....	.....	.....	.....	167·6*	.....	4 2 (4)		7 4		45,098(e)	(5) This cost rate is for the survey and settlement records completed for attestation and assessment with soil maps.
Gorakhpur do.	.....	28·1	.....	.....	.....	.....	56·4*	.....	.....	.....	178·7*	.....	4 6 (5)		2 5		1,35,734(f)	(6) This cost-rate is for the area in which the Cadastral Survey has been completed, and includes the cost of writing the khasras under the Benares system. First season's operations.
Kamrup do.	.....	56·7	.....	.....	.....	.....	.....	.....	.....	.....	327·9*	.....	8 2 (6)		8 1		94,041(g)	
Pegu and Shwegyin districts	.....	80·5	.....	.....	.....	.....	.....	.....	.....	.....	290·6*	.....	7 3		11 3		1,70,019(h)	
Prome and Akyab do.	.....	63·4 74·6	.....	.....	.....	38·3	.....	.....	.....	.....	386·1*	.....	9 8		3 11		1,63,013(i)	
Spirit-levelling, India	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	56,662	
Orissa and Ganjam coast	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22,620	

* Inclusive of Triangulation and Traversing.

† Cost, high, as the party was engaged in the Aka hills with the Military Expedition, and little work could be done.

Abstract of areas and cost-rates of the Revenue Branch parties according to Jurisdictions.

Provinces.	Scale of Survey.	Area in square miles.	Cost.	Rate per square mile.	Remarks.
			Rs. A. P.	Rs. A. P.	
North-West Provinces	32 inches = 1 mile.	11	7,855 0 0	687 11 7	Cadastral, including khasra writing, &c.
	16 do. = 1 do....	1,736	2,91,570 2 9	169 10 11	Ditto ditto.
	4 do. = 1 do....	147	7,456 5 11	52 1 4	
	2 do. = 1 do....	1,507	46,359 9 7	30 11 11	
Punjab	12 do. = 1 do....	4	1,969 6 11	492 5 9	
	6 do. = 1 do....	64	2,603 1 8	40 10 9	
	2 do. = 1 do....	1,782	46,759 5 11	26 3 10	
Assam	16 do. = 1 do....	223	91,941 14 3	327 15 1	This cost-rate is for the area in which the cadastral survey has been completed and includes khasra writing, &c.
British Burma	16 do. = 1 do....	1,749	5,24,326 16 9	299 13 7	
	2 do. = 1 do....	163	6,249 9 1	38 5 5	
Bombay	4 do. = 1 do....	612	38,834 5 0	63 8 7	
	2 do. = 1 do....	2,120	60,076 0 3	28 5 5	
Central Provinces...	16 do. = do....	31	21,768 2 11	173 9 3	Cadastral.
		209		70 1 10	Skeleton field blocks.
Rajputana	16 do. = ½ do....	91	11,466 8 5	126 0 1	Skeleton traverse.
	Total ...	10,154 sq. miles + 291 blocks	11,64,207 8 5	.....	

Districts completed since last Report.

District.	Number of villages.	Number of fields.	Area in square miles.	Cost.	Rate per square mile.	Nature of survey, by whom, and when surveyed.	Remarks.
				Rs.	Rs. A. P.		
Ballia	1,562	887,989	725 (a)	113,795	156 15 4	Surveyed cadastrally on the scale of 16 inches to a mile by Majors W. Barron and S. H. Cowan during 1880 to 1884.	(a) Exclusive of parganas Bhadaun and Sikandarpur surveyed during seasons 1874 to 1876 in Azamgarh district and which have since been transferred to Ballia.
Benares	2,316	992,674	1,003	152,735	152 4 3	Surveyed cadastrally on the scale of 16 inches to a mile by Majors W. Barron and S. H. Cowan during 1882 to 1884, together with the khasrahs.	
Mirzapur	2,953	1,548,996	2,426	365,918	151 7 5	Surveyed cadastrally on the scale of 16 inches to a mile by Colonel F. C. Anderson during 1879 to 1883, together with the khasras during 1881-82.	
Aligarh	.....	.....	2,011 (b)	50,179	23 15 11	Surveyed topographically on the scale of 2 inches to a mile by Messrs. R. T. S. Johnson, J. O. N. James, and Major R. H. Steel during 1852 to 1854.	(b) Includes 6·6 square miles of Aligarh city surveyed on 6-inch scale.
						A line of villages, area 101 square miles, along the rivers Ganges and Jumna have been surveyed on 4-inch scale. Excluding 4-inch work, the cost rate of the 2-inch work is Rs. 29-11-7 per square mile.	
Hissar	.....	.....	3,511 (c)	114,560	32 11 6	Surveyed on the scale of 2 inches to a mile by Colonel D. Macdonald and Colonel F. Coddington during 1862 to 1864, together with skeleton traverses for a subsequent cadastral survey by Settlement Department.	(c) Includes 64 square miles of Government Cattle Farm surveyed on 6-inch scale and 4 square miles of Hissar city surveyed on 12-inch scale.

Surveyor-General's Office,
Calcutta, 1*st October* 1885.

H. R. THUILLIER, *Lieut.-Col.*, R.E.,
Deputy Surveyor-General.

Tabulated Statement of the principal records prepared in the several Recess Offices of the Field Parties of the Revenue Branch for the year ending 30th September 1884.

Province and District.	Survey Party.	Mapping.						Traverses.		Field Books.		Area Books.		For Settlement Department.		Remarks.
		Original field sections.	Cadastral 16-inch sheets.	Sheets, 4-inch = 1 mile. 7¾′ × 8¾′	Quarter sheets, 2 inch = 1 mile, 15′ × 15′ × 7½′	Index maps.	Triangulation charts.	Main circuit with azimuth computations.	Village or sub-circuit.	Main circuit.	Village or sub-circuit.	Villages.	Fields.	Sheets or tracts.	Village areas or khasras.	
North-Western Provinces.							Cadastral Surveys.									
Benares	No. IV	.....	1,115 62 on 32″	.....	6	... ..	.....	1	1 Trav. 1 Az.	1	By. 9 1	1,429	44	2,076	1,768	
Ballia	Ditto ...	.....	10	.....	.....	.....	.....	.....	.....	.....	By. 1	44	872,144			
Basti	Ditto ...	.....	185	.....	.....	1	.....	1	4		2	1				
								1 Az.	1 Az.	1	7	899	.....	.....	.....	
Dehra Dun	Detacht.	.....	525					2	5	1	10	279	98,087	343	317	
Gorakhpur	No. V ...	.....	1,500	10	12 (a)	1	.....	3	7	1	10	1,883	.....	3,141	1,455	(a) Only plotted.
Ballia and Azamgarh...	Ditto ...	9 on 4″	.....	.....	.....	.....	.....	.....	.....	.....	.....	31	.....	.....	.....	
Assam.															334 Villages.	
Kamrup	No. VI	.....	331	.....	3	1	.....	1 1 Az.	4	1	16	334	148,438	334	517 Nisfkhiraj. 46 Lakhiraj. 2 Waste Land Grants.	
Burmah.																
Pegu	No. II	.....	789	.....	24	.....	.....	3	4	3	9	219	.....	.....	.....	
Hanthawaddy	Ditto ...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	31	.....	.....	.....	
Prome	No. VII	5 Irrawaddy river on 2″	10 on 64″ 109	.....	.....	1	.....	.....	1	.....	1	16 Vols.	.....	31	.....	
Tharrawaddy	Ditto ...	.....	.....	.....	19	.....	.....	.....	.....	.....	.....	14 Vols.	.....	.....	.....	
Akyab	Ditto ...	3 Magu river on 2″	460	.....	.....	1	.....	2	2	2	4	.....	.....	76	.....	
Bassein and Henzada..	No. VIII	.....	840	.....	.....	.....	.....	1	4	.....	6	314	723,810	181	.....	
Central Provinces.																
Raipur	Chhattisgarh Detacht.	.....	42	.....	.....	1	.....	1	1	1	4	22	40,000	19	.....	Also 180 sheets mapped on 16″ of Field Blocks.
Rajputana.																
Ajmere-Merwara ...	Detacht.	.....	78	.....	.....	2	.....	1	1	1	1	.....	.....	.....	.....	
Punjab.		Village and Topographical Surveys.														
Hissar	No. I	56 on 2″ 13 on 6″ 6 on 12″	9 on 6″ 2 on 12″	.....	29 (b)	6 Atlas reductions.	.....	1	3	5	31	.....	.....	.....	Copies of all traverse data.	(b) In duplicate for reproduction and reduction.
Rawalpindi	Ditto ...	.....	.....	34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
North-Western Provinces.																
Aligarh, Etah, and Budaun.	No. III	1 on 6″ 11 on 4″ 82 on 2″ 8 (incomplete)	1 on 6″	.....	20 (c)	3 Atlas reductions. 1 Trace of reductions. 1 Contour map of height.		2 main 1 river	2 block. 1 river ...	1	4	.....	.....	2	.....	(c) 15 in duplicate for reduction and reproduction.
Bombay.																
Thana	No. X ...	55 on 4″ 9 on 2″	.....	44	7	1	.....	1	2	1	2	.....	.....	52 on 4″	Copies of all traverse data.	
Ratnagiri, Sholapur, Satara.	No. XI	25 on 2″	.....	.....	11	1 Tr. (Sheets 58, 59, 64 & 65).	.....	.....	1 (Sheets 58, 59, 64, & 65).	.....	2 (Sheets 58, 59, 64, & 65).	.....	.....	.....	.....	

Revenue Survey Branch Office,
Calcutta, the 1*st October* 1884.

H. R. THUILLIER, *Lieut.-Col.*, R.E.,
Deputy Surveyor-General.

CALCUTTA DRAWING OFFICE.

SECTION I.

Statement showing the nature of the work performed and the progress made from 1st October 1883 to 30th September 1884.

TITLE OF MAP.	Scale. In. Mls.	REMARKS AND PROGRESS.
India (crop map)	1 = 32	Specially prepared for Calcutta International Exhibition.
„ (forest map)	1 = 64	
„ (trade map)	1 = 64	
„ (telegraph map) ...	1 = 64	
„ (showing Missionary stations)	1 = 64	
„ (showing irrigation) ...	1 = 32	
„ in four sheets... ...	1 = 64	Additions for engraving.
„ for Education Commission report	1 = 96	Corrected railways.
Compilations.		
Guzerat (in 1 sheet) ...	1 = 16	A new compilation which is being made from all the recent surveys. It will include Guzerat, Kattywar, and Cutch, and will ultimately be engraved.
North-Western Provinces (in 2 sheets).	1 = 16	Compiled in outline from the latest surveys, and has been photo-zincographed.
Punjab (in 4 sheets)	1 = 16	Corrected to date in boundaries, &c., and published by photo-zincography. It will ultimately be engraved on copper.
Central India Agency (in 2 sheets)	1 = 16	Additions up to date in outline and hill shading. The engraving of the map is far advanced.
Rajputana Agency (in 2 sheets) ...	1 = 16	Ditto ditto ditto.
Peshawar	1 = 4	With tribal names corrected to date.
District Gurdaspur (in 4 sheets) ...	1 = 2	Compiled by special request for Punjab Government. It has been taken from revenue survey material adjusted to modern great trigonometrical survey values, and has been reproduced by photo-zincography.
Berars, Hyderabad Assigned Districts (in 1 sheet)	1 = 8	Hills in brush work finished and sent for engraving. The map has been compiled from the 1" = 1 mile topographical sheets, and will shortly be published.
Punjab (in 4 sheets)	1 = 16	Corrected to date owing to recent changes in boundaries, and is published in skeleton form by photo-zincography. It will be shortly engraved on copper, when hills will be added.
Burma (Fitzroy's map) in 4 sheets	1 = 4	Corrected to date, boundaries, railways, roads, &c.
District maps.		
District Dera Ismail Khan (in 2 sheets)	1 = 4	Specially called for by the Punjab Government on the 1-inch scale. Proofs were sent and the corrections and additions suggested by them have been carried out, and the map photo-zincographed. These compilations are being utilized for incorporation in the new revised sheets of the Atlas of India.
District Bannu (in 1 sheet) ...	1 = 4	
Do. Peshawar (in 1 sheet) ...	1 = 4	
District Jubbulpore	1 = 4	Prepared for lithogrgphy from copper-plate transfers of Atlas sheets.
„ Chanda	1 = 4	
„ Hoshangabad ...	1 = 4	
„ Chittagong	1 = 4	
„ Howrah	1 = 4	
„ Hooghly	1 = 4	
„ Naga Hills	1 = 4	
Province of Assam	1 = 16	Has been corrected up to date from information received from district officers, &c., &c.
British Burma, Pegu Division ...	1 = 4	Ditto ditto ditto.
District Damoh	1 = 4	Ditto ditto ditto.
Bengal, Behar, and Orissa ...	1 = 32	Ditto ditto ditto.
Rohilkhand Division	1 = 4	Ditto ditto ditto.
District Peshawar	1 = 4	Ditto ditto ditto.
„ Sylhet	1 = 4	Ditto ditto ditto.
N.-W. Provinces and Oudh ...	1 = 32	Ditto ditto ditto.
Punjab	1 = 32	Ditto ditto ditto.
District Cachar	1 = 4	Ditto ditto ditto.
„ Lakhimpur	1 = 4	Ditto ditto ditto.
„ Furreedpore	1 = 4	Ditto ditto ditto.
„ Midnapore	1 = 4	Ditto ditto ditto.
„ Mymensingh	1 = 4	Ditto ditto ditto.

CALCUTTA DRAWING OFFICE.

SECTION I.—*continued.*

	TITLE OF MAP.	Scale. In.	Mls.	REMARKS AND PROGRESS.
	District maps—contd.			
	N.-E. Frontier of Bengal ...	1 =	32	Showing tribal names.
	District Peshawar, Revenue Survey Sheets Nos. 3, 4, 6, 7, and 10 ...	1 =	1	Inserted boundary canals, railway, &c., &c.
PROVINCE OF BENGAL.	District Hazaribagh ...	1 =	8	Specially prepared for administration reports, and so drawn as to fit into a full or half-sheet of foolscap, and in accordance with latest instructions received from Surgeon-General, *vide* his memorandum of 6th June 1884. They have been drawn for the 8-mile district maps, or from the Atlas sheets reduced by pentagraph.
	,, West Duars ...	1 =	8	
	,, Orissa Tributary Mohals.	1 =	8	
	,, Chota Nagpore ...	1 =	8	
	,, Jashpur	1 =	8	
	,, Bankoora ...	1 =	8	
	,, Beerbhoom ...	1 =	8	
	,, Midnapore ...	1 =	8	
	,, 24-Pergunnahs ...	1 =	8	
	,, Khoolna	1 =	8	
	,, Dinagepore ...	1 =	8	
	,, Rungpore ...	1 =	8	
	,, Darjeeling ...	1 =	8	
	,, East Duars ...	1 =	8	
	,, Udepur	1 =	8	
	,, Julpigoree ...	1 =	8	
	,, Sundarbans ...	1 =	8	
	,, Backergunge ...	1 =	8	
	,, Chittagong ...	1 =	8	
	,, Ditto Hill Tracts	1 =	8	
	,, Patna	1 =	8	
	,, Gya	1 =	8	
	,, Shahabad ...	1 =	8	
	,, Mozufferpore ...	1 =	8	
	,, Sarun	1 =	8	
	,, Chumparun ...	1 =	8	
	,, Monghyr ...	1 =	8	
	,, Sonthal Pergunnahs...	1 =	8	
	,, Cuttack	1 =	8	
	,, Balasore ...	1 =	8	
	,, Morbhanj ...	1 =	8	
	,, Pooree	1 =	8	
	,, Lohardugga ...	1 =	8	
	,, Manbhoom ...	1 =	8	
	,, Singbhoom ...	1 =	8	
	,, Korea	1 =	8	
NORTH-WESTERN PROVINCES AND OUDH.	District Dehra Dún ...	1 =	8	
	,, Muzaffarnagar ...	1 =	8	
	,, Meerut	1 =	8	
	,, Bulandshahr ...	1 =	8	
	,, Bareilly	1 =	8	
	,, Budaun	1 =	8	
	,, Mainpuri ...	1 =	8	
	,, Etawah	1 =	8	
	,, Cawnpore ...	1 =	8	
	,, Allahabad ...	1 =	8	
	,, Hamirpur ...	1 =	8	
	,, Jaunpur ...	1 =	8	
	,, Basti	1 =	8	
	,, Jhansi	1 =	8	
	,, Lalitpur	1 =	8	
	,, Saharanpur ...	1 =	8	
	,, Bijnor	1 =	8	
	,, Shahjahanpur ...	1 =	8	
	,, Farukhabad ...	1 =	8	
	,, Banda	1 =	8	
	,, Gorakhpur ...	1 =	8	
	,, Garhwal (British) ...	1 =	8	
	,, Garhwal ...	1 =	8	
	,, Tarai	1 =	8	
	,, Unao	1 =	8	
	,, Barabanki ...	1 =	8	
	,, Sitapur	1 =	4	
	,, Hardoi	1 =	4	
	,, Kheri	1 =	4	
	,, Fyzabad	1 =	4	

CALCUTTA DRAWING OFFICE.

SECTION I.—*continued.*

TITLE OF MAP.	SCALE.	REMARKS AND PROGRESS.
Sheets of the Atlas of India.	In. Mls.	
4 N.E.	1 = 4	Compiled from recent surveys in North Afghanistan for engraving.
4 S.E.	1 = 4	
4 S.W.	1 = 4	Compiled from the 1" = 1 mile standards of the Punjab Revenue Survey.
5 S.E.	1 = 4	
5 N.E.	1 = 4	
6 N.E.	1 = 4	
6 S.E.	1 = 4	
8 S.W.	1 = 4	
12 N.W.	1 = 4	Outline and hill shading in brush for engraving.
12 S.W.	1 = 4	
13 S.E.	1 = 4	Hills in brush for engraving.
14 S.E.	1 = 4	Compiled from new surveys in Northern Afghanistan.
14 S.W.	1 = 4	
14 N.W.	1 = 4	
15 N.W.	1 = 4	New compilation, outline finished for engraving.
15 S.W.	1 = 4	
16 S.W.	1 = 4	
16 N.W.	1 = 4	
18 N.E.	1 = 4	Compiled from the 1" sheets of the Rajputana Topographical Survey, outline, sand hills and hill shading in brush for Engraving Branch.
18 S.E.	1 = 4	
19 N.E.	1 = 4	
19 S.E.	1 = 4	
20 N.E.	1 = 4	
20 S.E.	1 = 4	
22 N.W.	1 = 4	Outline and names for engraving.
28 Full sheet	1 = 4	Hills in brush shading, Hazara district, in hand.
29 Ditto	1 = 4	Insertion of railways.
30 Ditto	1 = 4	
33 N.E.	1 = 4	
35 N.E.	1 = 4	Outline and printing of a part.
35 S.E.	1 = 4	Hills redrawn for engraving.
35 S.E.	1 = 4	Corrections and additions.
37 S.E.	1 = 4	
38 N.W.	1 = 4	Hills in brush for engraving.
38 N.E.	1 = 4	Additions in hills for engraving.
38 S.E.	1 = 4	Outline and names of a part.
39 N.W.	1 = 4	Correcting outline.
48 N.E.	1 = 4	A small portion outlined for engraving.
48 S.E.	1 = 4	Outline and names of a portion and also hill shading in brush.
49 N.E.	1 = 4	A portion compiled in outline and names.
51 N.E.	1 = 4	Correcting sub-division boundary.
54 Full sheet	1 = 4	Correction to canals and railways.
65 Ditto	1 = 4	Additions in hills for engraving.
67 S.W.	1 = 4	Compiled from new revenue surveys, North-Western Provinces.
67 N.W.	1 = 4	
68 Full sheet	1 = 4	Additions in railways and canals.
69 S.E.	1 = 4	Hill shading in brush, of a part, for engraving.
88 N.E.	1 = 4	In course of completion.
88 S.W.	1 = 4	Outline and names.
89 Full sheet	1 = 4	Hill shading in brush of part.
103 Ditto	1 = 4	Additions to railways.
112 Ditto	1 = 4	
114 S.E.	1 = 4	Compiled outline of portion.
114 Full plate	1 = 4	Territorial names inserted.
115 N.E.	1 = 4	Outline and names for engraving.
120 Full plate	1 = 4	Additions, railways, and roads, &c.
121 Ditto	.....	
122 Ditto	.....	
Special maps.		
Behar Opium Agency	1 = 16	Compiled specially for the Opium Department.
Benares ditto	1 = 16	
Country in the vicinity of Aden ...	1 = 4	Trace made and kept on record.
Earthquake map	1 = 250	To illustrate the supertidal wave caused by the eruption at Java.
Map of the Paropamisan mountains.	1 = 8	Drawn specially for reproduction by photo-zincography.
India	1 = 32	For geological survey, showing geological symbols.

CALCUTTA DRAWING OFFICE.

SECTION I.—*continued.*

TITLE OF MAP.	Scale.	REMARKS AND PROGRESS.
Special maps—continued.	In. Mls.	
India, miniature map	1 = 500	For meteorological survey.
Do.	1 = 32	Showing density of population.
Do.	1 = 128	Drawn to illustrate reports showing internal railway trade.
N.-W. Provinces and Oudh ...	1 = 16	Showing positions of dispensaries, &c., *&c.*
Map of Persia	1 = 16	Plotted several stations, and entered route of Colonel Gerard's journey into Kurdistan.
Sketch map of Bengal ...	1 = 32	Showing routes and distances in miles.
Atlas sheet 37 and adjoining portions	1 = 4	Map compiled from Atlas sheets illustrating the different boundaries claimed by Holkar.
Province of Assam	1 = 16	For Sanitary Commissioner.
United States of America ...	.....	Specially called for by Revenue Commissioner's Department and prepared for reproduction by photo-zincography.
Map of Khorasan	1 = 24	Drawing on tracing cloth for reproduction by photo-zincography.
Kattywar	1 = 16	Specially prepared for Geological Survey.
Nerbudda valley	1 = 4	
British Garhwal	1 = 4	
India	1 = 32	
Do. (miniature)	1 = 50	
Map of Bengal	1 = 16	Showing ground under canal irrigation.
Peshawar	1 = 4	Showing tribal distributions for photo-zincography.
Map of Malwa	1 = 4	Trace from Sir J. Malcolm's map for Governor-General's Agent, Central India.
Central India, sheet No. 367 ...	1 = 1	A new edition of these sheets is being prepared. They are being completed up to margin by including the adjacent portions of the North-Western Provinces, and are numbered according to the new index of the sheets of Central India and Rajputana.
Ditto, ditto 368 ...	1 = 1	Sheets Nos. 367, 368, 369, and 399 have been drawn and sent for photo-zincography.
Ditto, ditto 369 ...	1 = 1	
Ditto, ditto 385 ...	1 = 1	
Ditto, ditto 386 ...	1 = 1	Sheets Nos. 386, 387, 400, 401, and 402, are far advanced in drawing and typing.
Ditto, ditto 387 ...	1 = 1	
Ditto, ditto 388 ...	1 = 1	
Ditto, ditto 399 ...	1 = 1	
Ditto, ditto 400 ...	1 = 1	
Ditto, ditto 401 ...	1 = 1	
Ditto, ditto 402 ...	1 = 1	
Ditto, ditto 403 ...	1 = 1	Sheets Nos. 403, 404, 405, 412, 413, 414, 415, 416, 417, 388, and 385 are in hand.
Ditto, ditto 404 ...	1 = 1	
Ditto, ditto 405 ...	1 = 1	
Ditto, ditto 412 ...	1 = 1	
Ditto, ditto 413 ...	1 = 1	
Ditto, ditto 414 ...	1 = 1	
Ditto, ditto 415 ...	1 = 1	
Ditto, ditto 416 ...	1 = 1	
Ditto, ditto 417 ...	1 = 1	
Ditto, ditto 423 ...	1 = 1	
Ditto, ditto 424 ...	1 = 1	
Southern Afghanistan and Pishin Valley maps, sheet No. 5 ...	1 = 4	Hill shading in verticals. Published.
Ditto, ditto 6 ...	1 = 4	
Ditto, ditto 7 ...	1 = 4	Hill shading in verticals and addition in printing. Published.
Ditto, ditto 8 ...	1 = 4	Hill shading in verticals. Published.
Ditto, ditto 9 ...	1 = 4	
Ditto, ditto 10 ...	1 = 4	Additions and corrections in names and hill shading. Published.
Ditto, ditto 11 ...	1 = 4	Hill shading in verticals. Published.
Ditto, ditto 12 ...	1 = 4	Outline and hill shading. Published in preliminary form.
Baluchistan.		
Northern half D. sheet X ...	1 = 2	Compiled from best survey. Outline, printing and hills. These sheets only require examination. They will be published by photo-zincography.
Southern ditto X ...	1 = 2	
Northern ditto VII ...	1 = 2	
Southern ditto VII ...	1 = 2	

CALCUTTA DRAWING OFFICE.

SECTION I.—*continued.*

TITLE OF MAP.	Scale. In. Mls.	REMARKS AND PROGRESS.
Special Maps.		
Index map, Central Provinces ...	1 = 32	Prepared in accordance with the orders of the Surveyor-General. The numbering of the standard 1-inch sheet is continuous throughout the whole province.
Ditto, Bengal	1 = 24	
Ditto, Central India and Rajputana Agency, sheet I	1 = 24	
Ditto ditto, sheet II ...	1 = 24	
Original standard sheets of the Mysore Topographical Party, sheets Nos. 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 49, and 50.	1 = 1	The divisional, district, and taluka boundaries have been altered since the survey was made, and the new boundaries have been inserted on the original sheets.
Miscellaneous Maps, &c.		
Rewah survey, sheet No. 6 ...	1 = 1	Touching up hill shading, names, &c., of original for photo-zincography.
Punjab	1 = 32	Inserted railways and telegraphs up to date.
Mallaby's map of Rajputana ...	1 = 4	Touched up for reproduction by photo-zincography.
City and environs of Ajmere ...	12 = 1	Additions up to date.
Muttra city and cantonment with environs.	2 = 1	Prepared for Gazetteer.
District Allahabad, No. 2 ...	1 = 6	
Ditto ditto ...	1 = 8	For R. A. C. Department.
Route map to Bagdad ...	1 = 16	For Quarter-Master-General.
Trace of boundary between Nepal and Oudh.	1 = 4	
Rajputana sheet No. 53 ...	.....	Corrected boundary on original and 200 copies of the photo-zincographed sheets.
Gwalior and Central India sheet No. 96.	.....	
Skeleton-plan of Darjeeling ...	.....	Corrected to date.
Projection of maps and charts on different scales.	.....	
285 Originals and proofs examined and corrected for photo-zincography and lithography.	Various scales.	Entered on counterfoil receipt book and despatched.
11,281 Sheets of various maps ...	ditto	Coloured as standard office copies.

N.B.—In addition to the above, various other small jobs, such as tracings, typing hand-printing, colouring and plottings have been performed in the compiling branch when necessary.

G. A. McGILL, *Surveyor, 1st grade,*
Chief Draftsman.

C. STRAHAN, *Major*, R.E.,
Assistant Surveyor-General,
In charge Drawing Office.

SURVEY OF INDIA OFFICE,
Calcutta, 1st October 1885.

CALCUTTA DRAWING OFFICE.

SECTION H.

TITLE OF MAP.	Scale.	REMARKS.
	Inch. Mile.	
Punjab.		
Districts Bannu, Dera Ismail Khan, and Thal of Muzaffargarh in 44 standard sheets, 30′ × 15′.	1 = 1	The remaining 10 standard sheets Nos. 34, 35, 37, 38, 39, 40, 41, 42, 42A, and 42B, scale 2 inches = 1 mile, were examined, completed, and sent to press for reduction to ½ scale. The above standard sheets have been all published, with the exception of standard sheets Nos. 39 and 42. Number of standard sheets published up to date, 42.
District Hissar.		
In 14 standard sheets, 30′ × 15′ ...	1 = 1	The standard sheets, Nos. 275, 276, 277, and 278, drawn on the scale of 2 inches = 1 mile for reduction to scale of 1 inch = 1 mile, in the Executive's office, have been completed up to margin by the insertion of the topography from the surveys of district Rohtak and the Patiala and Jind States, which adjoin the district of Hissar. The first two standard sheets have been examined and sent to press; the other two are in a well-advanced state.
Do. in quarter sheets, 15′ × 7½′ ...	2 = 1	The standard sheets prepared for reproduction to scale in the Executive's office were compared with the plane-table sections, all necessary corrections made, and sent to press for publication.
Indus River.		
In six sheets	2 = 1	Thirty-four original 4-inch sheets, survey of 1872-73, were prepared and sent to press for reduction into six sheets. These maps were specially prepared to suit the requirements of the Financial Commissioner of the Punjab. The proofs of these sheets were all passed with final press order.
North-West Provinces.		
Districts Moradabad, Budaon, Tarai, and part of Rampur State in 22 standard sheets, 30′ × 15′.	1 = 1	The proofs of standard sheets, Nos. 30 and 46 reported last year, were examined and passed with final press order. All published.
District Banda in 16 standard sheets, 30′ × 15′.	1 = 1	The proofs of standard sheets Nos. 112, 112A, 127, 125, 141, 142, 143, 155, and 156 were examined and passed with final press order. This completes the publication of the district.
District Banda, 4 sheets, showing Forest Reserves.	4 = 1	Geographical lines were inserted on the 4-inch sheets Nos. 67, 68, 85, 86 of this district. These maps were specially prepared to meet the requirements of the Superintendent of Government Forests. They were re-examined and sent to press for publication to scale.

CALCUTTA DRAWING OFFICE.

SECTION II.—*continued.*

TITLE OF MAP.	Scale.	REMARKS.
Jumna River Survey.	Inch Mile.	
From the trijunction of districts Dehra Dún, Umballa, and Shaharanpur to the City of Dolhi.	4 = 1	The original maps of this survey were prepared in the Executive's office in 53 sheets. These were reduced by photography to 33 sheets, and an index map was prepared in this office showing their position and numbering. The sheets with the index map were sent to press for reproduction. The proofs were examined and the final press order was issued.
City of Kasganj.		
District Etah in 9 sheets for reproduction.	20 = 1	The original sheets Nos. 1-9, which were prepared in the Executive's office, were re-examined and sent to press for publication. These sheets were prepared to meet the requirements of the Municipality of Etah.
Meerut Division.		
Districts Saharanpur, Muzaffarnagar, Meerut, Bulandshahr, and Aligarh in quarter sheets, 15′ × 7½′.	2 = 1	The proofs of standard sheets Nos 8, 9, 19, 20, 32, and 33 were all examined and passed with final press order. The original sheets Nos. 21, 22, 34, 35, and 51 drawn in the Executive's office were carefully compared with the plane-table sections, all corrections made, and sent to press for publication on the same scale. These show village boundaries.
Ditto ditto in standard sheets, 30′ × 15′.	1 = 1	The proofs of standard sheets Nos. 8, 9, 19, 20, 32 and 33, which were sent to press last year, were passed with final press order, standard sheets Nos. 21, 22, 34, 35, and 51 drawn in the Executive's office were completed up to margin by the insertion of the topography from the adjoining districts of Gurgaon and Muttra in this office; they were examined and sent to press for reduction to half scale. These maps do not show village boundaries. Number of standard sheets published up to date, 25.
Oudh.		
New edition in 64 standard sheets, 30′ × 15′.	1 = 1	The proofs of standard sheets Nos. 106, 121, 123, have been passed with final press order. Standard sheets Nos. 135, 137 and 152 were sent to press for corrections to be made and all omissions supplied. The proofs of standard sheets Nos. 88, 150, and 164 have been sent to the different Deputy Commissioners for examination of thana and pargana boundaries. Their return is awaited, when they will be examined and sent to press with final press order. Number of standard sheets published up to date, 18.

CALCUTTA DRAWING OFFICE.

Section II.—*continued.*

Title of Map.	Scale. Inch Mile.	Remarks.
Bengal.		
District Jalpaiguri. Old edition in 13 standard sheets, 30′ × 15′.	1 = 1	The proofs of standard sheets Nos. 1-13 were compared with the proofs received from the different local officers and sent to press for correction and preliminary publication.
New edition in 15 standard sheets, 30′ × 15′.	1 = 1	The first proofs of standard sheets Nos 270, 271, 293, 294, 315, 316, 337, and 338 of the new edition with the second proof of standard sheet No. 337 have been sent to press.
District Pooree, Killah Khorda.		
In 65 imperial sheets	4 = 1	The remaining 25 sheets were completed in this office, carefully examined, and sent to press. The first proofs of the above sheets have been examined and returned to press for correction.
District Cuttack.		
In 3 standard sheets, 30′ × 15′ ...	1 = 1	Geographical lines were inserted on 24 sheets of the 4″ maps, comprising standard sheets Nos. 194, 195, 196, and sent to press for photographic reduction to half scale, and blue prints called for.
Hooghly River Survey.		
Sheets Nos. 1-9 comprising 116 sections.	16 = 1	These sheets are all now undergoing examination, and all necessary corrections are being made to fit them for reproduction by photography to scale. The sections of sheet No. 7 were sent to press for reproduction by photography. These sections were reduced into five sections to meet the requirements of the Port Commissioners. The proofs of these were all passed with an order for a preliminary edition.
Sheets Nos. 1-4 were surveyed on scale 16″ = 1 mile and reduced by pentagraph to 8″ = 1 mile.	8 = 1	
Sheets Nos. 5-9 surveyed on scale 16″ reduced to 6″.	6 = 1	
Sheets Nos. 1-10	3 = 1	
Sheets Nos. 1-10 reduced by pentagraph to two sheets Nos. 1 and 2.	1 = 1	
Mymensingh.		
District Mymensingh in 23 standard sheets, 30′ × 15′.	1 = 1	An error having been discovered in the compilation of these sheets, the work of computing had all to be revised. This furnished the drawing office an opportunity of completing the sheets up to margin. The skeleton standard sheets, which were prepared for the guidance of the lithographic office in preparing the transfer drawing to be put down on stone, with the 1″ original pargana maps, have been sent to the lithographic office.
Burma.		
District Hanthawaddy in quarter sheets, 15′ × 7½′.	2 = 1	The original standard sheets Nos. 114, 116, and 125 drawn in the Executive's office were re-examined, carefully compared with the cadastral plans, and sent to press. The press order proofs of the above-mentioned sheets, with sheets Nos. 123, 124, 132, and 133, were passed for publication.

CALCUTTA DRAWING OFFICE.

SECTION II.—*continued.*

TITLE OF MAP.	Scale.	REMARKS.
Burma—concluded.	Inch Mile.	
District Bassein in quarter sheet, 15′ × 7½′.	2 = 1	The original sheets Nos. 103, 104, 112, 113, 121, 122 drawn in the Executive's office were re-examined, compared with the cadastral plans, all needful corrections made, and sent to press for reproduction to scale.
District Tharrawaddy in quarter sheet, 15′ × 7½′.	2 = 1	The original sheet No. 90 drawn in the Executive's office was re-examined and compared with the cadastral plans, all needful corrections made, and sent to press for reproduction to scale.
Town of Rangoon.		
In 19 sheets	16 = 1	Nineteen original sheets with an index map showing the disposition of the sheets were received from the Executive's office and sent to press with orders for a preliminary edition, to meet the immediate requirements of the Rangoon Municipality.
Bombay.		
Konkan survey	1 = 1	The standard sheets Nos. 78 and 83 drawn in the Executive's office on the scale of 2″ = 1 mile for reduction to half scale were compared with the plane-table sections and sent to press for publication.
Ditto	4 = 1	The sections of standard sheets Nos. 78, 79, 83— Sheet 78 N. W. (1, 2, 3, 4,) N. E. (1, 2, 3, 4,) S. W. (1, 2, 3, 4,) S. E. (1, 2, 3, 4), Sheet 79 S. W. (2,) S. E. (4), Sheet 83 N. E. (1, 2, 3, 4,) S. E. (1, 2, 3, 4,) S. W. (2, 4), and the original field sections of standard sheet 79 S. W. (1, 3, 4,) and S. E. (1, 2, 3) received from the Executive's office were examined, all necessary corrections made for reproduction to scale, and sent to press for publication. Proofs of sections of standard sheet No. 79 S. W. (1, 2, 3, 4,) S. E. (1, 2, 3, 4) were passed on to press with an order for a preliminary edition, to meet the requirements of the Forest Department.
Deccan Survey	1 = 1	The proofs of standard sheets Nos. 60, 66, 67, and 90 were examined and passed with final press order. The fair standard sheets Nos. 51, 58, and 59 drawn in the Executive's office on the scale of 2′ = 1 mile for reduction to half scale were compared with the plane-table sections and sent to press for publication.
Ditto	2 = 1	The original sheets Nos. 32 S. W. and N. W. 37, prepared in the Executive's office, were re-examined and passed with final press order for reproduction to scale to meet the requirements of the Executive Engineer of the Irrigation Department, Poona Division.

CALCUTTA DRAWING OFFICE.

SECTION II.—*continued.*

TITLE OF MAP.	Scale.	REMARKS.
Index Maps.	Inch Mile.	
Districts Rawalpindi and Hissar (Punjab), Meerut Division; districts Gorakhpur, Basti, Dehra Dún, Ballia, Benares and Mirzapur (N.-W. P.); Ajmere-Mhairwara (Rajputana); district Raipur (Central Provinces); district Kamrup (Assam); Hanthawaddy, Bassein, Prome, Akyab (British Burma); the Deccan and Konkan (Bombay Presidency).	On various scales.	The Index maps of Hissar, Dehra Dún, Raipur, Kamrup, Prome, Akyab and Gorakhpur have been redrawn; the others have been revised and brought up to date for the annual report of 1883-84.

DESCRIPTION OF WORK.	REMARKS.
Computations Examined.	
District Hanthawaddy, Seasons 1880-82.	
Districts Ghazipur and Ballia, Seasons 1878-81.	
District Mirzapur, Seasons 1878-81.	
Traverse Data, &c., supplied.	
Of Main Ct. 2 and 3, Mirzapur along Benares ...	For Deputy Superintendent.
Of Main Ct. 1, Pargana Jalesar along districts Agra, Etah, and Aligarh.	Ditto.
Of Main Ct. 7, district Bassein along district Thôngwa	Ditto.
Of Main Ct. 1, district Tharrawaddy along district Hanthawaddy.	Ditto.
Of district Dera Ghazi Khan along Sindh ...	For Settlement Commissioner, Punjab.
Of certain villages of Patna (old and new surveys) ...	For Collector.
Of 11 villages of district Pubna	Ditto.
Of 28 villages of district Furreedpore	Ditto.
Of 5 villages of district Tirhoot	For Sub-divisional Officers.
Of district Sylhet along the Balisira hills ...	For Officer in charge of No. 6, Topographical Party.
Of certain Ganges Bearah villages, district Saran ...	For Collector.
Plotting columns of 321 villages of district Budaun ...	For Deputy Superintendent.
Plotting columns and distances of Khorda villages (88 pages).	For Settlement Officer.
Miscellaneous Works.	
Computations for the projection of district Mymensingh, Allahabad City, Saugor Cantonments, a portion of Jind State and a portion of district Lakhimpur.	
Calculation of Lat. and Long. of Revenue Survey points for the ¼-inch projection of districts Jhansi and Jalaun. Preparation of summary and other tables for annual report, and examination of tables received from Executives, &c.	

CALCUTTA DRAWING OFFICE.

SECTION II.—*continued.*

TITLE OF MAP.	Scale.	REMARKS.
Miscellaneous Traces, &c.	Inch Mile.	
Gogra river between Azamgarh and Gorakhpur showing a line of villages along bank of former district, in duplicate.	4 = 1	For Deputy Superintendent.
An index to the above	1 = 2	For Deputy Superintendent.
Meerzha Deara, &c., showing old and new survey district Rajshahye.	4 = 1	For Collector.
Plan of 1 village, district Bhagalpur	4 = 1	Ditto.
Sheet No. 67, district Jessore ...	4 = 1	Ditto.
Sheet No. 7, civil station of Hissar ...	4 = 1	For Deputy Superintendent.
Boundary between districts Muttra and Gurgaon showing one line of villages.	4 = 1	For Settlement Officer.
Plans of 2 villages of district Monghyr.	4 = 1	For Collector of Patna.
Portion of Kidderpore ...	6 = 1	For Port Commissioners.
2 Sheets of boundary between Nanukmutha and Pilibhit.	4 = 1	For Superintendent, Tarai district.
Ganges Deara Survey, district Rajshahye.	4 = 1	For Collector.
Ditto ditto ...	1 = 1	For Collector.
15 Traces of boundary between Tipperah Raja's dominions and British territory (in duplicate).	8 = 1	For Collector of Tipperah.
Boundary between Dera Ghazi Khan and Sindh.	4 = 1	For Settlement Commissioner.
Plan of 5 villages of district Nuddea.	4 = 1	For Collector.
Boundary between Maler Kotla, Shahpur, Patiala State.	2 = 1	Ditto.
2 Sheets of district Tipperah (in duplicate).	8 = 1	Ditto.
1 Sheet of district Furreedpore ...	4 = 1	Ditto.
Mozufferpore city and surrounding country.	8 = 1	For Collector of Mozufferpore.
Fyzabad city and cantonment ...	8 = 1	For Executive Engineer, Oudh Division.
Portion of Ganges Deara between districts Bhagalpur and Maldah, season 1847-48.	4 = 1	For Collector.
The same portion surveyed in season 1865-66.	1 = 1	For Collector.
Boundary of pargana Balisira, district Sylhet.	4 = 1	For Officer in charge No. 6 party, Topographical Branch.
Boundary between districts Gonda and Basti.	4 = 1	For Deputy Superintendent.
Plans of 2 villages of district Mymensingh.	4 = 1	For Collector of Mymensingh.
Plans of 6 villages, district Sylhet ...	4 = 1	For Collector of Sylhet.
Portion of Tarai district ..	2 = 1	For Deputy Conservator of Forests.
Portion of district Rajshahye bordering on district Maldah showing road from Godagiri to Dinagepore.	4 = 1	For Chairman, Road Committee.
Portion of district Hazara ...	4 = 1	For Executive Engineer, Military Works.
Levels entered on 30 traces of Oudh...	4 = 1	Ditto, Oudh Division.
	Ft.	
Grand division No. 4, sub-division No. 2, Panchannogram.	1 = 99	For Collector.

CALCUTTA DRAWING OFFICE.

SECTION H.—*concluded.*

TITLE OF MAP.	Scale.	REMARKS.
	Inch Mile.	
30 Traces from published maps for comparison of boundaries with settlement maps of Allahabad, Aligarh, Azamgarh, Cawnpore, Etah, Etawah, Farukhabad, Fatehpur, Mainpuri, and Shahjahanpur.	.....	For the Deputy Surveyor-General.
Forest boundaries and roads inserted on 6 sets of maps of district Goalpara.	1 = 1	For Deputy Commissioner, Goalpara.
Villages boundaries inserted on 6 sheets of district Ajmer (in duplicate).	1 = 1	For Major Steel.
Village boundaries inserted on 4 sheets of Mhairwara.	1 = 1	Ditto.
Village boundaries inserted on sheet No. 6, Jessore.	4 = 1	For Collector.
Map Colouring.	No of maps.	
Maps on various scales	146	For Surveyor-General's Office.
Ditto ditto	146	For Deputy Surveyor-General's Office.
Ditto ditto	900	For India Office.
Ditto ditto	1,170	For district officials.
Examination of Proof Sheets.		
Photo-zincographed maps ...	323	
Lithographed maps	61	

S. M. SMYLIE,
Surveyor and Head Draftsman.

C. STRAHAN, *Major*, R.E.,
Assistant Surveyor-General,
In charge Drawing Office.

SURVEY OF INDIA OFFICE;
Calcutta, 1st October 1884.

CALCUTTA DRAWING OFFICE.

SECTION III.

State of publication of Cadastral Maps on the 30th September 1884.

DISTRICTS.	NUMBER OF SHEETS.							REMARKS.
	MAPS PREPARED.			PUBLISHED.				
	Up to 30th September 1883.	Added during past 12 months.	Total up to 30th September 1884.	Up to 30th September 1883.	DURING 1884.			
					By Surveyor-General's Office.	Total to 30th September 1884.	Remaining to be published.	
N.-W. Provinces.								
Agra	2,924	.....	2,924	2,924	.....	2,924	.....	
Azamgarh	930	.....	930	930	.....	930	.....	
Balia	1,391	.....	1,391	1,050	293	1,343	48	
Banda	3,317	.....	3,317	3,317	.....	3,317	.....	
Benares	.....	644	644(b)	.....	556	556	88	
Bijnour	31	.....	31	31	.....	31	.....	
Ghazipur	3,050(a)	.....	3,050	3,034	16	3,050	.....	(a) Figures of previous return have been changed to agree with final results.
Hamirpur	2,926	.....	2,926	2,926	.....	2,926	.....	
Jaunpur	3,434	.....	3,434	3,434	.....	3,434	.....	
Moradabad and Tarai ...	4,023	.....	4,023	4,023	.....	4,023	.....	
Muttra	1,658	.....	1,658	1,658	.....	1,658	.....	(b) Those figures are liable to alteration until publication has been completed.
Mirzapur	3,733	.....	3,733(b)	2,606	823	3,434	304	
Terai	94	.....	94(b)	55	39	94	.....	
Total ...	27,516	644	28,160	25,988	1,762	27,750	440	
British Burma.								
Bassein	2,716(a)	48(c)	2,764	1,993	453	2,446	318	(c) Sheets of Bassein Municipality surveyed on the scale of 64 inches to the mile.
Hanthawaddy and Pegu ...	3,885	760	4,585	3,041	734	3,782	803	
Henzada	139	54	193	.....	101	101	92	
Prome	.....	726	726	.....	286	286	440	
Tharrawaddy	1,363(a)	.....	1,363	1,074	83	1,157	206	
Total ...	8,103	1,528	9,631	6,115	1,657	7,772	1,859	
Bengal.								
Patna and Gya	3,054	.....	3,054	3,054	.....	3,054	.....	
Shahabad	4,924	.....	4,924	4,924	.....	4,924	.....	
Poorea (Khorda estate) ...	4,629	.....	4,629	1,635	1,641	3,276	1,353	
Total ...	12,607	.....	12,607	9,613	1,641	11,254	1,353	
Assam.								
Sylhet	61	.....	61(b)	16	.....	16	45	
Total ...	61	.....	61	16	.....	16	45	
GRAND TOTAL, N.-W. PROVINCES, BURMA, BENGAL, AND ASSAM. ...	48,287	2,173	50,459	41,732	5,060	46,792	3,667	

Detail of examination in connection with Publication.

PROVINCES.	NUMBER OF SHEETS.				REMARKS.
	Examined and rendered suitable for photo-zincography.	Traced and examined for zincography.	Proof copies examined previous to press order.	Coloured and subsequently examined.	
N.-W. Provinces	733	864	1,873	1,762	Scale 16 inches=1 mile.
British Burma	1,453	524	1,710	1,637	Scale 16 inches=1 mile.
Bengal	857	841	1,643	1,641	„ 32 ditto.
Assam	.....	.....	.....	.....	„ 16 ditto.
Total ...	3,073	2,229	5,226	5,060	

R. C. D. EWING,
Assistant Surveyor and Draftsman.

W. H. WILKINS, *Lieut.-Col.*,
Deputy Supdt., Survey of India,
In charge Cadastral Section.

SURVEY OF INDIA OFFICE;
Calcutta, 1st October 1884.

WORK DONE BY THE EXAMINING SECTION FROM 1st OCTOBER 1883 TO 30TH SEPTEMBER 1884.

Subjects examined ...	Original standard sheets, large scale plans, and triangulation charts of topographical surveys	72
	Original compilations of parts of atlas sheets and other maps compiled in Survey of India Offices	71
	Engraved proofs in outline and names, &c., in various stages, as well as of general and provincial maps	104
	Photographed and lithographed proofs on various scales, including maps, plans, atlas sheets, &c., together with additional work of corrections in territorial changes and public constructions, such as boundaries, canals, roads, &c.	255
Projection of graticule and plotting of points ...	Projection of atlas sheets and provincial maps, &c.	103
Miscellaneous	Tracings of sketches, charts, and supply of geographical data to various officials, computation of graticule for the plates of the Indian atlas, and projection of the same on copper, calculation of areas, &c.	

F. ADAMS,
Surveyor, 2nd grade, and Geographical Examiner.

CHARLES STRAHAN, *Major*, R.E.,
Assistant Surveyor-General, In charge Drawing Office.

SURVEY OF INDIA OFFICE,
Calcutta, 1st October 1885.

PROGRESS REPORT OF THE ENGRAVING OFFICE FROM 1ST OCTOBER 1883 TO 30TH SEPTEMBER 1884.

General Maps, &c.

TITLE OF MAP.	Outline.	Writing.	Hills and sand.	Remarks showing progress.
	Sq. in.	Letters cut.	Sq. in.	
Map of India, in six sheets, scale 1 inch = 32 miles—				
Sheet I ...	.....	7,585	.....	Additional writing done.
,, III ...	.....	36	.....	Slight corrections done.
,, IV ...	.....	.....	168 H.	Hills well advanced; in progress.
Map of India in four sheets, scale 1 inch = 64 miles ...	155	89	142 H.	Heavy additions and corrections to Afghan frontier. Map published.
Skeleton map of India in four sheets, scale 1 inch = 64 miles	.....	15,870	.....	Well advanced; nearly finished, additions in progress.
Map of India in two sheets, scale 1 inch = 80 miles ...	.....	2,300	.....	Corrections and additions to railways and outline.
Map of India, scale 1 inch = 96 miles	.....	457	.....	Ditto ditto.
Map of India in outline, small, "Meteorological" ...	.....	.....	.....	Corrections to outline, sea and dotted ruling engraved.
Central Provinces in two sheets, scale 1 inch = 16 miles ...	.....	.....	.....	Slight corrections done.
Central India Agency in two sheets, scale 1 inch = 16 miles	12½	131	.....	Corrections and additions to outline and writing in progress.
Rajputana in two sheets, scale 1 inch = 16 miles ...	20	5,350	6 H. 25 S.H.	Additional outline and writing in progress.
Assam, scale 1 inch = 16 miles	.....	.....	173 H.	Plate nearly finished; slight additions; in progress.
Berar, scale 1 inch = 8 miles...	.....	431	58 H.	Border taken out and recut title cut; hills in progress.
Map of Himalayan routes, scale 1 inch = 32 miles ...	.....	2,887	.....	Plate finished.
Index chart to Great Trigonometrical Survey ...	.....	14	.....	Slight additions, finished up to date.
Large alphabets, four sets ...	.....	.....	.....	Finished.
Paper graticule plate, scale 1 inch = 1 mile ...	.....	484	.....	Plate finished.
Graticule scales between 7° and 30° 30'	.....	16,356	.....	Comprising 84 scales on twelve plates; engraved and finished.
Tirhoot State Railway forms ...	24	1,060	.....	Two forms on one plate; finished.
Section tints in ½", 1/12", and 1/24" divisions, each 22" square ...	.....	300	.....	Three plates engraved and finished.
Section plate, 18½" × 12½", to register the rise and fall of rivers, for the Punjab Government	.....	1,984	.....	In divisions for each day of the year; engraved and finished.
Calcutta International Exhibition certificate	.....	.....	.....	Plate touched up and title engraved.
Map headings	.....	1,750	.....	Additions done.
Imprint plates	.....	2,258	.....	New plates engraved.
Date plates	.....	273	.....	Dates altered.
Heliogravure plates by Major J. Waterhouse	.....	4,019	.....	Touched up and titles cut; in all about 11 plates.
Brass Tangent scales for Math. Instrument office.	.....	22,769	.....	Figures engraved and finished to twenty-three scales.
Bronze medal for a native explorer	.....	420	.....	Engraved and finished.
Table drawn for office use				
Total ...	326	86,813	537 H. 25 S.H.	

ENGRAVING OFFICE—*continued.*

A FULL SHEET OF THE INDIAN ATLAS CONTAINS 927·2 SQUARE INCHES; A QUARTER SHEET 231·8 SQUARE INCHES.

Indian Atlas Sheets (new) completed and published.

TITLE OF MAPS, &c.	Outline.	Writing.	Hills and sand.	Remarks showing progress.
	Sq. in.	Letters cut.	Sq. in.	
13 N.W.	.....	300	8 H.	Hills, marsh, and district names engraved.
22 S.E.	2	3,576	.....	Completed up to margin.
32 N.W.	.....	261	118 S.H.	
36 N.E.	.....	20	28 H.	
48 S.E.	21	4,794	6 S.H.	Published in outline as preliminary edition.
67 N.E.	40	2,289	9 H.	Completed up to limits of survey.
76 S.E.	.....	196	28 H.	Completed up to margin.
Total ...	63	11,436	73H. 124 S.H.	

Indian Atlas Sheets (new) in progress.

4 S.E.	184	.....	.....	Border and outline engraved writing in progress.
12 S.W.	83	860	.....	Outline engraved; writing in progress.
13 S.E.	50	2,805	.....	Additional outline and writing; waterlining; trigonometrical stations and district names engraved; hills about to be commenced.
14 S.E.	52	.....	.....	Outline in progress.
18 N.E.	.....	738	132 S.H.	Plate nearly finished.
18 S.E.	20	.....	.....	Additional outline cut.
19 N.E.	130	1,878	.....	Outline finished; writing in progress.
19 S.E.	57	607	.....	Ditto ditto.
20 N.E.	159	6,376	.....	Outline done; writing well advanced; in progress.
20 S.E.	46	509	.....	New outline and writing done as far as material supplied.
23 S.E.	54	8,047	.....	Additional outline and writing in progress.
35 N.W.	24	2,436	.....	New survey; outline and writing done; awaiting hill drawing.
35 S.W.	79	979	.....	Outline done as far as materials supplied; writing in progress.
37 S.E.	32	820	45 H.	Hills in progress.
37 S.W.	.....	2,404	.....	Small portion of outline and additional writing cut.
38 N.W.	.....	10,232	5 H.	Outline and writing finished as far as material supplied; hills in progress.
38 N.E.	18	.....	.....	Outline completed as far as material supplied.
38 S.W.	.....	3,479	.....	Writing in progress.
38 S.E.	162	4,718	.....	Outline finished; writing in progress.
39 N.W.	73	.....	.....	Portion of outline taken out and re-engraved.
39 N.E.	198	.....	.....	Outline done up to margin.
39 S.W.	231	.....	.....	Border cut; outline done up to margin.
39 S.E.	131	.....	.....	Outline done up to margin.
40 N.E.	22	9,000	.....	Writing in progress.
40 S.E.	3	1,988	.....	New portion of outline and writing in progress.
48 N.E.	101	.....	.....	Outline nearly finished; in progress.
49 N.E.	.....	10,406	.....	Writing in progress.
49 S.W.	150	.....	.....	Re-projected and border cut; outline in progress.
49 S.E.	231	.....	.....	New scale cut; outline done up to margin.
Carried over ...	2,280	68,282	50 H. 132 S.H.	

ENGRAVING OFFICE—*continued.*

Indian Atlas Sheets (new) in progress—concluded.

Title of Maps, &c.	Outline.	Writing.	Hills and sand.	Remarks showing progress.
	Sq. in.	Letters cut.	Sq. in.	
Brought forward ...	2,280	68,282	50 H. 132 S.H	
50 S.E.	123	8,769	.....	Writing in progress.
61 N.E.	5	14,325	.....	Outline and writing completed as far as material supplied.
61 S.E.	.....	16,532	.....	Writing about $\frac{4}{5}$ths done; in progress.
67 S.W.	55	.....	.....	New outline in progress.
69 S.E.	.....	1,758	.....	Outline and writing of fresh survey completed; hills about to be put in hand.
75 S.E.	108	.....	.....	Re-projected, border cut, and outline done as far as material supplied.
76 N.W.	119	4,959	.....	Outline finished as far as material supplied; writing nearly completed.
76 N.E.	2	7,573	.....	Marsh and waterlining done; 376 lakes ruled; awaiting hill drawing.
76 S.W.	.....	7,000	.....	Writing in progress.
77 N.W.	.....	4,924	.....	Waterlining and writing finished; awaiting drawing for hills.
77 S.E.	10	669	4 S.H.	Waterlining marsh and sand done; 549 lakes ruled; outline and writing done as far as drawing.
78 N.E.	.....	8,000	.....	Writing in progress.
79 N.W.	137	52	.....	Projected and border cut; outline completed as far as material supplied.
79 S.W.	212	118	.....	Re-projected; outline done as far as material supplied; writing just commenced.
88 S.W.	110	32	.....	Projected and border cut; outline completed as far as material supplied.
114 N.E.	96	.....	.....	Outline completed as far as material supplied.
114 S.E.	165	252	.....	Writing in progress.
115 N.E.	37	.....	.....	Small portion of outline done.
131 N.E.	.....	2,842	28 H.	Hills in progress.
Total ...	3,469	146,687	78 H. 136 S.H.	

Additions and Corrections to the Indian Atlas Sheets.

1A S.E.	.....	154	.....	Title cut.
8 S.E.	.....	.....	.....	Slight corrections finished.
13 N.E.	.....	362	4 H.	Corrections and additions to district names; border cut.
22 S.W.	.....	134	.....	Additional boundaries cut.
23 N.W.	.....	416	.....	Corrections and additions done.
23 S.W.	.....	300	.....	District names cut.
32 N.E.	.....	90	.....	Slight additions done.
32 S.W.	.....	.....	4 S.H.	Slight corrections done.
34 N.W.	.....	.....	.....	Corrections and additions done.
34 S.W.				
34 S.E.				
35 N.E.				
35 S.E.	.....	.....	19 H.	Heavy additions; new portion of survey; corrections and additions to district names done.
44A N.W.	.....	154	.....	Title cut.
66 S.W.	.....	56	.....	Slight corrections finished.
66 S.E.	.....	32	.....	Ditto.
87 N.W.	.....	1,049	.....	Additional railways and names cut.
87 N.E.				
87 S.W.				
87 S.E.				
Total ...	.....	2,747	23 H. 4 S.H.	

ENGRAVING OFFICE—*concluded.*

Repairs and additions to old plates of the Indian Atlas.

Title of Map.	Outline.	Writing.	Hills and sand.	Remarks showing progress.
	Sq. in.	Letters cut.	Sq. in.	
28	150	7,852	.....	Old work taken out; border cut, new outline, sand banks and dry bed of river engraved; heavy alterations and additions; writing in progress.
29	.....	100	.....	Additional railways and names cut.
30	5	107	.....	Additional railways and corrections to outline and writing done.
31	5	300	.....	Additional outline and writing done.
37	.....	100	.....	Additional writing done.
46	.....	.....	104 H.	Hills being repaired; in progress.
47	.....	.....	76 H.	Hills being repaired; 571 square inches of hills stopped out for re-biting by Photo. office.
49	.....	450	.....	Additional writing done.
54	3	100	.....	Additional outline and writing done.
55	4	123	.....	
65	15	221	8 H.	Portion of new survey done.
89	17	500	36 H.	Portion of new survey and old hills touched up, done.
102	8	200	.....	Additional outline and writing done.
103	.....	850	.....	Portion of writing re-cut.
107	.....	.....	303 H.	Hills being repaired; in progress.
112	13	207	.....	Additional outline and writing done.
120	3	.....	.....	
121	.....	329	.....	
Total ...	223	11,439	527 H.	

New plates projected, borders cut, &c.

4 N.E.	.....	.....	.....	Border cut.
5 N.W., S.W., & S.E. ...	.....	.....	.....	Projected and borders cut.
7 N.E. & S.E.	.....	.....	.....	Projected.
15 Four quarters ...	.....	.....	.....	Projected and borders cut.
16 Ditto ...	.....	.....	.....	
17 N.W. & S.E.	.....	.....	.....	Projected.
17 N.E. & S.W.	.....	.....	.....	Projected and borders cut.
27A S.W.	.....	.....	.....	
42 Four quarters ...	.....	.....	.....	
43 N.E.	.....	.....	.....	Projected.
43 S.E.	.....	.....	.....	Projected and border cut.
57 N.E.	.....	.....	.....	Border cut.
78 S.W.	.....	80	.....	Re-projected and border cut.
88 N.W.	.....	.....	.....	Projected.
88 N.E. & S.E.	.....	.....	.....	Projected and borders cut.
125 S.E.	.....	.....	.....	Projected.
131 S.E.	.....	.....	.....	Border cut.
146 N.E.	.....	.....	.....	Re-projected.
Total ...	.....	80	.....	

Abstract of work completed and in progress.

Engraving.

	Plates.
Atlas sheets completed	7
Ditto in progress in various stages	48
General maps, plans, &c.	84
Repairs, corrections, and additions ...	38
Projections, engraved borders cut, &c. ...	33
Total ...	210

Copper-plate printing.

Impressions taken	18,200
Proofs pulled	470
Transfers pulled	384
Total ...	19,054

Steel-facing.

	Plates.
Double elephant plates, steel-faced ...	42
Ditto ditto, steel-removed	32
Quarter-plates, steel-faced ...	45
Ditto, steel-removed ...	38
Miscellaneous plates, steel-faced ...	47
Ditto ditto, steel-removed...	26
Total ...	230

Square inches of hill etching ...	1,527
Ditto of jungle etched ...	50
Ditto of outline engraved ...	4,031
Number of letters engraved ...	259,202

C. W. COARD,

Superintendent, Engraving Office.

C. STRAHAN, *Major*, R.E.,

Assistant Surveyor-General,
In charge Engraving Office.

Extract from the Report of MAJOR J. WATERHOUSE, R.C., *Assistant Surveyor-General in charge, Lithographic Office, Survey of India Department, season* 1883-84.

I HAVE the honour to submit the usual tabular statements showing the amount and cost of the work turned out in the Lithographic Office during the survey year commencing 1st October 1883 and ending 30th September 1884, viz :—

L_1. Statement of departmental work lithographed and printed.
L_2. Statement of work lithographed and printed for other departments.
L_3. Statement of type work.
L_4. General abstract of outturn and value of work done.

The progress of the office during the year will be seen from the tabular abstract given below, in which the outturn of the year is compared with that of the previous one :—

	1883-84.			1882-83.		
	Number of subjects.	Number of copies printed.	Value.	Number of subjects.	Number of copies printed.	Value.
			Rs. A. P.			Rs. A. P.
Departmental maps, &c. ...	153	23,046	17,473 15 2	211	26,667	19,631 0 0
Ditto forms ...	49	54,004	4,427 15 3	53	40,810	4,615 0 0
Extra-departmental maps, &c. ...	500	108,146	23,212 11 11	471	196,366	22,767 0 0
Total ...	702	185,196	45,114 10 4	735	263,843	47,013 0 0
Type work	4,184	351,347	12,148 1 6	3,198	323,817	9,530 0 0
Total value ...	.....	.....	57,262 11 10	.....	.....	56,543 0 0

The number of maps and drawings, both departmental and extra-departmental, lithographed and printed during the year, though somewhat less than last year, is still well above the average. The extra-departmental work shows an increase, and the increase in the type work is again very considerable.

The total number of impressions in the lithographic printing rooms was 178,474, of which 80,169 were departmental and 98,305 for other departments.

The principal items of work done have been noticed in the accompanying abstract (printed in part I). and need not be repeated.

Mr. H. L. Lepage, Head Assistant, returned from furlough on the 5th July. Mr. A. G. Palmer of the Engraving Office, who had been officiating for Mr. Lepage, went on furlough for one year from the 1st of May, and the officiating appointment was held by Mr. L. C. Cunningham till Mr. Lepage's return.

Mr. J. Watson of the Photographic Office remained as officiating head lithographic printer till the arrival from England, on the 18th February, of Mr. D. Deas, who was appointed head printer by the Secretary of State from the 29th November 1883. Mr. B. Wilson who had been working for some time in the Photographic Office was appointed as assistant lithographic printer from the 18th February 1884.

All these assistants have performed their duties very satisfactorily. Mr. Cunningham is an excellent draftsman, both on stone and paper, and is a great acquisition to the office. Mr. Deas, the new head printer, seems to understand his work thoroughly, and does it efficiently.

Mr. DePyvah, type printer, has again had to meet a large increase of work in the type-printing section, and has done it well and cheerfully.

The native assistants and clerks have all worked well. I regret to have to record the death from cholera of Baboo Boloram Nath, who had been in the office for upwards of 32 years, and was an excellent draftsman in various styles. His loss is greatly felt.

Baboo Grish Chunder Biswas, press assistant, who had officiated as head clerk for many years, retired on superannuation pension from the 1st October. He knew the work of the office well, and is also a loss.

Messrs. G. A. LeFranc and E. Dowling have been entertained as apprentices from the 1st August 1884, in conformity with Government Resolution No. 298 (Surveys), dated 15th July 1884. They are both doing well.

General Walker, the late Surveyor-General, having retired in January, made over his interest in the premises No. 1, Camac Street, in which this office is located, to the office, and arrangements have been made with the landlord for a renewal of the lease on its expiry in February next, on the same terms as at present. The premises have just undergone general repairs, but as it was arranged that the repairs in the office rooms should be done during the Doorga Poojah holidays, the work suffered no interruption.

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC OFFICE, SURVEY OF INDIA DEPARTMENT, BETWEEN THE 1ST OCTOBER 1883 AND 30TH SEPTEMBER 1884.

L. 1.

Work done for the Survey Department.

Description of Maps.		Scale of maps.	Size of each sheet.	Number of sheets.	Number of colored copies.	Number of uncolored copies.	Total number of copies.	Number of impressions.	Value.	Remarks.
									Rs. A. P.	
General Maps.										
Drawn during the year.										
Afghanistan, sheet No. 1 ...	Outline drawn on stone.	1 inch = 4 miles	Atlas ...	1	...	.....	.....	.....	198 0 9	Not yet printed.
India, in 6 sheets, sheets Nos. 1 to 6, 3rd issue.	Re-transfer made with corrections and additions.	1 inch = 32 miles	Double elephant.	6	...	1,800	1,800	1,500	969 12 6	
Contour sheets, Nos. 2 and 4, of the Outline Map of India.	Re-transfer made with contour lines, corrections, and additions.	Ditto ...	Ditto ...	2	...	.....	.....	.....	320 0 6	Ditto.
Ditto, Nos. 1 and 3 of ditto	Corrections and additions made.	Ditto ...	Ditto ...	2	...	.....	.....	.....	255 3 11	Ditto.
Irrigation Map of India, in 6 sheets, sheets Nos. 1 to 6.	Re-transfer made with corrections, and color stones prepared.	Ditto ...	Ditto ...	6	...	.....	.....	.....	111 1 3	Ditto.
Missionary Map of India, in 2 sheets.	Ditto ...	1 inch = 64 miles	Ditto ...	2	...	.....	.....	.....	133 15 11	Ditto.
India, illustrating Distribution of Languages.	Ditto ...	1 inch = 96 miles	Ditto ...	1	...	112	112	112	127 2 5	
India, showing Principal River Basins.	Ditto ...	Ditto ...	Ditto ...	1	...	112	112	112	127 10 7	
Reprints.										
India, in 6 sheets, sheets Nos. 1 to 6, 2nd issue.	.....	1 inch = 32 miles	Double elephant.	6	...	387	387	387	295 15 0	
India	.....	2 " = 96 "	Ditto ...	1	...	200	200	200	74 13 4	
British Burmah, sheets Nos. 3 and 4.	.....	1 " = 4 "	Ditto ...	2	...	180	180	180	66 0 6	
Southern Afghanistan, in 4 sheets, sheets Nos. 1 to 4.	.....	Ditto ...	Double elephant.	4	...	367	367	734	306 10 4	
India, showing the present state of the progress of the Imperial Survey to 1st October 1883, to accompany annual report.	Corrections made and color stones prepared.	1 inch = 128 miles	Imperial ...	1	500	.....	500	1,500	212 6 2	
Provincial Maps.										
Drawn during the year.										
Nizam's dominions, including the Assigned District of Berar, in 2 sections.	1st Section drawn on stone.	1 inch = 16 miles	Double elephant.	4	....	...	...	...	3,215 1 5	Not yet printed.
North-Western Provinces and Oudh.	Re-transfer made with corrections and additions.	1 " = 32 "	Imperial ...	3	...	...	...	...	42 7 6	Ditto.
Punjab Province	Ditto ...	1 " = 64 "	Foolscap ...	1	...	...	...	...	11 6 4	Ditto.
Transferred previously from engraved sheets, but printed during the present year.										
Bengal, Behar, Orissa, and Chota Nagpore.	Further corrections made.	1 " = 32 "	Double elephant.	1	...	250	250	250	89 5 5	
Drawn previously, but printed during the present year.										
2 Sheets of the title sections of the map of Province of Bengal.	.....	1 " = 8 "	Imperial ...	2	...	200	200	200	41 14 0	
Reprints.										
North-Western Provinces and Oudh, in 4 sections.	.....	1 " = 16 "	Imperial ...	4	...	50	50	400	83 5 6	
Central Provinces, in 2 sections...	Corrections made.	Ditto ...	Double royal	2	...	200	200	400	169 8 7	
Bengal, Behar, Orissa, and Chota Nagpore, in 4 sections.	.....	Ditto ...	Atlas ...	4	200	...	200	1,000	300 8 0	
Divisional Maps.										
Madras Presidency	Re-transfer made with corrections and additions.	1 inch = 32 miles	Antiquarian ...	1	...	105	105	105	179 0 2	
Bombay ditto	Ditto ...	Ditto ...	Ditto ...	1	...	102	102	102	91 8 0	
District Maps.										
Transferred from the engraved sheets of the Atlas of India.										
Jubbulpore	Corrections and additions made.	1 inch = 4 miles	Antiquarian ...	1	...	200	200	200	239 2 7	
Lakhimpur	Ditto ...	Ditto ...	Double elephant.	1	...	202	202	202	137 6 11	
Howrah	Ditto ...	Ditto ...	Super-royal ...	2	...	150	150	150	402 4 6	
Chanda	Ditto ...	Ditto ...	Antiquarian ...	1	...	.....	.....	.....	65 5 1	
Cachar	Ditto ...	Ditto ...	Double elephant.	1	...	.....	.....	.....	101 2 1	Not yet printed.
Hothangabad	Ditto ...	Ditto ...	Double royal	1	...	.....	.....	.....	13 6 1	
Carried over ...	.....	.....	.....	59	700	4,447	5,317	6,634	6,491 9 0	

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC OFFICE—*continued.*

Work done for the Survey Department—continued.

Description of Maps.		Scale of maps.	Size of each sheet.	Number of sheets.	Number of colored copies.	Number of uncolored copies.	Total number of copies.	Number of impressions.	Value.	Remarks.
District Maps—*concluded.*									Rs. A. P.	
Brought forward ...	.....	.....	.....	59	760	4,617	5,317	8,634	6,091 9 0	
Transferred previously from the engraved sheets, but printed during the present year.										
Chittagong, in 2 sections	Further corrections made.	1-inch = 4 miles	Atlas	2	...	202	202	404	229 6 3	
Naga Hills	Ditto ...	Ditto ...	Special ...	1	...	150	150	150	141 9 3	
Hooghly	Ditto ...	Ditto ...	Double royal	1	...	150	150	150	88 6 6	
Reprints.										
Furreedpore	Corrections, &c., made.	Ditto ...	Atlas	1	...	233	233	233	110 9 0	
Sylhet	Ditto ...	Ditto ...	Double elephant.	1	...	209	209	209	202 9 9	
Mymensingh	Ditto ...	Ditto ...	Antiquarian ...	1	...	100	100	100	150 6 4	
Balaghat	.....	Ditto ...	Double elephant	1	...	50	50	50	27 4 6	
Khoolna	.....	Ditto ...	Atlas	1	...	150	150	150	46 7 6	
Rajshahye	.....	Ditto ...	Do.	1	...	54	54	54	24 0 6	
Kamrup	.....	Ditto ...	Do.	1	...	54	54	54	24 0 6	
Hoshiarpur, in 4 sections ...	.....	1-inch = 2 miles	Imperial. ...	4	...	202	202	808	273 5 4	
Plans of Cantonments and Cities.										
Reprints.										
Plan of Calcutta	.....	3 inches = 1 mile	Super-royal ...	1	...	150	150	150	23 11 2	
Ditto	.....	1½ " = 1 "	Foolscap ...	1	...	100	100	100	11 10 2	
Atlas-Sheets.										
Transferred from Copper-Plate.										
Indian Atlas, full sheet, Nos. 43 and 61.	.....	1 inch = 4 miles	Antiquarian ...	2	...	155	155	155	116 15 4	
Indian Atlas, quarter sheet, No. 124 N.E.	.....	Ditto ...	¼ sheet Atlas...	1	...	100	100	100	29 4 9	
Transferred previously from Copper-Plate.										
Indian Atlas, full sheet, No. 39 ...	Further corrections made.	4 inch = 4 miles	Antiquarian...	1	...	200	200	200	141 9 1	
Reprint.										
Indian Atlas, full sheet, No. 48 ..	.....	4 inch = 4 miles	Antiquarian...	1	...	50	50	50	46 5 2	
Standard, Sheets.										
Drawn during the year.										
Oudh Revenue Survey, sheets Nos. 86, 87, 88, 105, 106, 116, 118, 119, 137, and 156, 2nd edition.	Drawn on transfer paper.	1-inch = 1 mile...	Double royal	10	...	.....	.....	.....	5,050 10. 2	Not yet printed.
District Julpaiguri, sheets Nos. 220, 220, and 337.	Re-transfer made with corrections, &c.	Ditto ...	Ditto ...	3	...	.....	.....	.....	62 13.10	Ditto.
Drawn previously, but printed during the present year.										
Oudh Revenue Survey, sheets Nos. 105, 121, 123, and 165, 2nd edition.	Corrections, &c., made.	1 inch = 1 mile...	Double royal	4	...	1,128	1,128	1,128	726 4 9	
District Julpaiguri, sheets Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13.	Ditto ...	Ditto ...	Ditto ...	13	...	571	571	571	1,114 13 2	
Index Maps.										
Drawn and printed during the year.										
Index to the standard sheets of Bengal, on the scale of 1 inch = 1 mile.	Re-transfer made with corrections and additions.	1-inch = 32 miles	Double royal	2	...	100	100	100	236 15 0	
Index to the sheet maps of Central Provinces Topographical Survey, on the scale of 4 inch = 1 mile.	Re-drawn on stone and color stone prepared.	.....	Foolscap ...	1	50	.....	50	100	22 10 11	
Index to the standard sheets of Central Provinces, on the scale of 1 inch = 1 mile.	Re-transfer made with corrections and additions.	1-inch = 32 miles	Double royal	1	...	50	50	50	87 6 0	
Drawn previously, but printed during the present year.										
Index to the standard sheets of Assam, on the scale of 1 inch = 1 mile.	Further corrections made.	1 inch = 32 miles	1 sheet double royal.	1	...	152	152	152	33 14 0	
Index to the standard sheets of Punjab, on the scale of 1 inch = 1 mile.	Ditto ...	Ditto ...	Ditto ...	1	...	100	100	300	33 13 1	
Carried over ...	.....	.....	.....	116	760	9,621	9,671	13,946	15,197 9 3	

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC OFFICE—*continued.*

Work done for the Survey Department—concluded.

DESCRIPTION OF MAPS.		Scale of maps.	Size of each sheet.	Number of sheets.	Number of colored copies.	Number of uncolored copies.	Total number of copies.	Number of impressions.	Value.	REMARKS.
REPRINTS.									Rs. A. P.	
Brought forward ...	.....	.....	.....	116	750	9,621	9,771	13,916	16,197 9 6	
Index maps, Nos. 1, 2, 5, 6, 7, 8, and 9, Topographical parties, of standard sheets, on the scale of 2 inches, 1 inch, ½ inch, and ¼ inch = 1 mile, to accompany annual report.	Corrections, &c., made and colour stones prepared.	Various scales	Foolscap ...	6	3,300	300	3,600	7,476	567 15 10	
Index to the Survey of South Sylhet and Tipperah Hills, on the scale of 1 inch = 4 miles, 1 inch = 2 miles, and 2 inches = 1 mile, to accompany annual report.	Ditto ...	1 inch = 8 miles	Ditto ...	1	550	50	600	1,150	96 3 7	
Index to the sheets of the Topographical Survey, district Kohat, on the scale of 1 inch = 1 mile, to accompany annual report.	Ditto ...	1 inch = 16 miles	Ditto ...	1	565	50	615	1,150	72 3 2	
Index map of district Teral, on the scale of 1 inch = 1 mile, to accompany annual report.	Ditto ...	1 inch = 8 miles	Ditto ...	1	550	50	600	1,150	87 7 6	
Index map of district Hissar, on the scale of 4 inches = 1 mile, to accompany annual report.	Ditto ...	Ditto ...	¼ sheet imperial.	1	535	50	603	1,140	94 4 7	
Index to the Indian Atlas showing the state of the Engraving to 1st October 1883, of sheets on the scale of 4 inch = 4 miles, to accompany annual report.	Ditto ...	1 inch = 256 miles	Foolscap ...	1	566	50	616	1,182	81 13 0	
Index to the Indian Atlas showing the sheets that have been published to 1st October 1883, of sheets on the scale of 1 inch = 1 mile, to accompany annual report.	Ditto ...	Ditto ...	Ditto ...	1	525	50	575	1,100	109 9 5	
Index to the Indian Atlas, on the scale of 1 inch = 4 miles.	Ditto ...	1 inch = 128 miles	Imperial ...	1	105	.....	105	210	45 15 7	
Index to the standard sheets of the North-West Provinces and Oudh, on the scale of 1 inch = 1 mile.	.....	1 inch = 32 miles	Ditto ...	1	...	102	102	102	13 6 4	
Total ...	.....	.....	.....	136	7,466	9,723	17,189	28,650	16,357 8 8	
Miscellaneous maps, &c.	.....	.....	.....	5	...	.....	.....	.....	171 8 0	Not yet printed.
Ditto ditto	.....	.....	.....	20	...	.....	5,557	4,540	945 3 6	
Departmental forms	.....	.....	.....	4	...	.....	.....	.....	33 13 6	Ditto.
Ditto ditto	.....	.....	.....	45	...	.....	54,004	46,020	4,302 1 7	
GRAND TOTAL ...	.....	.....	.....	202	7,466	9,723	77,050	89,169	21,901 14 5	

L 2.

Work done for other Departments.

NAMES OF DEPARTMENTS.	Number of maps.	Number of sheets.	Number of sheets colored.	Number of sheets uncolored.	Number of copies printed.	Number of impressions.	Value.
							Rs. A. P.
Foreign Department	54	54	.....	54	4,056	3,202	1,704 0 5
Military Department	97	92	5	92	6,152	3,451	2,047 5 5
Revenue and Agricultural Department	5	5	.....	5	641	517	146 4 6
Telegraph Department	5	5	.....	5	5,650	6,500	566 6 3
Bengal Secretariat	29	29	15	14	8,206	4,799	783 13 1
Quarter-Master-General	11	11	.....	11	2,988	1,856	830 15 11
Meteorological Reporter to the Government of India ...	20	21	5	16	9,536	12,745	2,205 10 6
Ditto ditto ditto of Bengal ...	1	1	.....	1	100	100	34 12 0
Archæological Survey of India	7	7	.....	7	4,025	2,875	931 15 5
Geological Survey of India	8	8	4	4	4,559	7,974	1,109 8 4
North-West Provinces Gazetteer	6	6	.....	6	2,676	2,676	595 6 8
Asiatic Society	14	14	1	13	11,797	8,172	621 2 11
Public Works Department, Government of Bengal ...	5	5	.....	5	746	746	581 4 2
Ditto ditto, ditto of North-West Provinces and Punjab	3	6	3	3	2,627	6,904	2,298 14 7
Public Works Department, Government of India ...	4	4	1	3	763	1,425	424 5 0
Punjab Government	2	2	.....	2	1,324	1,324	283 4 0
Fort Commissioners' Office	1	1	1	.....	165	495	175 6 7
Sanitary Commissioner with the Government of India ...	1	1	.....	1	812	1,624	198 0 0
Ditto ditto ditto of Bengal ...	1	1	1	.....	425	425	465 4 10
Superintendent, Government Printing, India	24	24	.....	24	7,813	2,607	307 7 2
Ordnance Department	12	12	.....	12	11,232	2,530	232 0 4
Board of Revenue	13	13	4	9	6,132	8,752	1,312 3 7
Medical Store Department	2	2	.....	2	300	300	45 12 3
Adjutant General's Office	12	12	.....	12	2,424	816	169 13 7
Engineer-in-Chief, Behar-Assam State Railway	12	12	.....	12	3,200	1,200	487 7 5
Stationery Office	6	6	.....	6	1,525	1,525	227 10 7
Miscellaneous maps, plans, diagrams, &c.	38	38	5	33	10,272	12,705	2,181 15 6
Maps, &c., drawn, but not printed	103	103	10	93	.....	.....	2,144 7 2
Total ...	496	500	55	445	108,146	98,305	23,212 11 11

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC OFFICE—*continued.*

L 3.

Statement of Type-work, exclusive of transfers, &c., already included in the cost of several lithographed maps, &c.

Subject.	Items.	Number of copies.	Number of impressions.	Value. Rs. A. P.
Circular Orders	49	10,433	12,033	364 9 0
Memoranda, &c.	476	223,807	324,686	5,459 5 0
Forms, &c., for Survey Department	82	90,071	253,935	4,531 14 0
Transfers of headings, footnotes, references of published maps, for Litho. and Photo. Offices	3,577	27,036	27,036	3,381 0 0
Rubber stamps made for Survey Department	.....	.....	.....	101 13 6
Total	4,184	351,347	617,690	13,838 9 6
Deduct value of transfers, &c., already included in the cost of several lithographed maps	.....	.....	.....	1,690 8 0
Balance	4,184	351,347	617,690	12,148 1 6

L 4.

General Abstract of Outturn and Value of Work performed.

Description of Maps.	Number of sheets.	Number of copies.	Number of impressions.	Value. Rs. A. P.
Departmental Work.				
General maps	22	8,658	5,025	2,164 6 4
Provincial ,,	13	900	2,850	693 9 6
Divisional ,,	2	207	207	270 8 2
District ,,	18	2,097	2,905	1,923 10 0
Plans of Cantonments and Cities	2	250	250	35 5 9
Atlas sheets	5	503	503	324 8 7
Standard sheets	17	1,699	1,699	1,840 1 11
Index maps	19	7,870	15,186	1,579 9 0
Miscellaneous maps, &c.	20	5,357	4,349	945 1 6
Departmental forms	45	54,004	46,690	4,392 1 7
Maps, &c., drawn, but not printed	39	.....	.....	7,733 0 1
Total	202	77,050	80,169	21,901 14 5
Work done for other departments	500	108,146	98,305	23,212 11 11
Total of Drawing and Printing in Lithographic Office	702	185,196	178,474	45,114 10 4
Work done in Type Department, items	4,184	351,347	617,690	12,148 1 6
Total Value	.....	.....	.....	57,262 11 10

Statement of Expenditure.

	Rs. A. P.
One-third pay of Superintendent	5,200 0 0
Establishment	34,319 2 1
Contingent charges	5,046 13 0
Total	44,565 15 1

Survey of India Department,
Lithographic Office,
Calcutta, the 1st October 1884.

J. WATERHOUSE, *Major*, R.E.,
Assistant Surveyor-General,
In charge Lithographic Office.

Extract from the Report of MAJOR J. WATERHOUSE, R.C., *Assistant Surveyor-General, in charge Photographic Office;—season* 1883-84.

I HAVE the honour to submit the usual tabular statements of work done, expenditure, &c., in the Photographic Office, Survey of India Department, during the survey year from 1st October 1883 to 30th September 1884, viz :—

A. Abstract of work performed during 1883-84.
B. Comparative statement of outturn of 1882-83 and 1883-84.
C. Statement showing the value of work done for other departments.
D. Statement of expenditure and value of work done.

OUTTURN.—(*Ordinary.*)—The number of original maps and drawings received for reproduction during the year was considerably less than in the previous year; consequently the outturn generally is smaller, though fairly up to the average. The decrease is principally in standard sheets and other departmental publications. The ordinary extra departmental work was of the same amount and miscellaneous character as usual; but a large amount of silver printing and also of heliogravure and collotype was done in connection with the Calcutta International Exhibition.

(*Cadastral.*)—The number of cadastral sheets reproduced during the year was 5,202, or 89 more than last year. Of these, 2,976 were photo-zincographed and 2,226 zincographed. The total number of copies printed off was 6,825 less than last year.

The work of the office was somewhat interfered with by a fire which occurred early in November in the upper floor of No. 1, Wood Street, by which three almirahs containing stationery, file-proofs, and valuable chemicals were completely burnt, and more or less damage done to everything in the upper floor by the heat and smoke. Full particulars of the occurrence were reported at the time. Fortunately the building itself was not seriously injured, and as the repairs were overdue, the premises were repaired inside and out. This was done without any extra expense, and arrangements were made for carrying on the work without occupying other premises. Every effort was made to ascertain how the fire originated, but nothing could be discovered beyond the fact that it was caused either intentionally or accidentally by some one who entered the premises and broke open one of the burnt almirahs, which contained ordinary office stationery.

EXPENDITURE.—The expenditure of the office during the year has been Rs. 1,27,763-5, as shown in Table D, or Rs. 30,327 more than last year. This large increase of expenditure is principally due to increase of establishment and pay of Messrs. Haward and Turner, additional house rent for No. 2, Wood Street, cost of four new presses and additional stores procured from England in anticipation of an extension of the cadastral survey, cost of two new presses from Allahabad for printing the new administration maps, also a press and other stores sent out by General Walker for the collotype work. The cost of a new camera indented for in 1882 and supplies of paper indented for in 1883, which arrived late, and should have been included in last year's accounts, have also helped to swell the expenditure during the year beyond its normal amount. The total amount credited to the office is Rs. 1,26,532-11-10. The value of work done for other departments amounted to Rs. 24,468, which is well above the average, but on the other hand the value of the departmental work shows a large falling off, being only Rs. 23,986, and the balance against the office is Rs. 1,230.

PERSONNEL.—Mr. H. Haward, who, as reported last year, was appointed by the Secretary of State, Head Assistant, arrived from England on the 11th January 1884, and took over charge of the collotype work, to which he has been specially trained. On his arrival, Mr. A. W. Turner, who had been officiating as Special Assistant, became supernumerary, but I was able to retain his services in connection with taking photographs of the principal Indian art exhibits in the Calcutta Exhibition, the expense being borne by the Government of Bengal. Afterwards, under sanction of the Government of India, Mr. Turner was appointed temporarily as Special Assistant for eight months, from the 1st of May, in order to work up the process of heliogravure. Baboo Kally Dass Seal, Chief Draftsman of the Marine Survey, was, with the sanction of the authorities of the Marine Survey, transferred to the office as Chief Draftsman and Engraver. He joined on the 1st September, and proved useful in touching up the heliogravure plates. I may take this opportunity of reporting that this assistant, who promised to do valuable service in connection with the heliogravure processes, died early in November last, and his place will be most difficult to fill, as he was an excellent draftsman, a good engraver, an amateur photographer, and generally a man of more varied talent than men of his class usually are.

Mr. Watson returned from deputation at the Lithographic office on the 3rd March, and resumed charge of the cadastral zinc-printing section. Mr. B. Wilson, who had been employed as an assistant zincographer on the cadastral establishment, was transferred to the Lithographic office as assistant lithographic printer from the 17th March.

With the sanction of Government, four apprentices have been appointed to the office and are being trained in various sections.

PROCESSES.—No changes have been made in the ordinary working processes of the office.

Collotype.—Mr. Haward, the new Head Assistant, being specially skilled in the working of this process, it was started again on his arrival, and has been carried on more or less steadily since; stoppages having occurred for want of suitable paper. The principal work done by this process was printing the gold medal award certificates for the Calcutta International Exhibition, of which 1,150 copies were supplied. A commencement has been made

of producing a series of permanent photographs of objects of art in the Exhibition for publication. Two plates of views of Mussooree and Naini Tal have also been done for the Gazetteer of the N.-W. Provinces. Notwithstanding Mr. Haward's skill in working the process, and the fact that he has been working with excellent and reliable formulæ kindly communicated by the Autotype Company of London, great difficulties have been met with in working in the hot weather. With further experience, however, it is hoped that these will be overcome, and the process be made capable of being worked steadily at all seasons. Mr. Haward also tried some experiments in making grained transfer prints for the reproduction of half-tone subjects on zinc or stone, but they were not more successful than previous attempts of the same kind.

Heliogravure.—Under Mr. A. W. Turner considerable progress has been made in these processes, particularly in a new method which is practically a modification of Fox Talbot's old process of photoglyphic engraving. In this method the image is etched on the copper through a negative pigment print, which forms a reserve of different thicknesses in different parts of the image, thin in the shadows and thick in the lights, which offer a corresponding resistance to the action of the etching fluid, and thus the plate is deeply hollowed out in the shadows where there is little or no gelatine, while in the high lights, where the gelatine is thickest, the copper is scarcely affected, and retains its polish. This method has several advantages over the process we have hitherto used, in which a positive gelatine pigment print is developed on the copper plate and then electrotyped, in being much quicker. Instead of taking three weeks or a month, as required for electrotyping, the preparation and etching of a plate can be finished in a day. A reversed negative is not required, any good ordinary negative being suitable. The effects produced are much richer and fuller in gradation than is generally the case with the photo-electrotype prints. At the same time much more artistic and manipulatory skill is required in producing and working up the plates, and the etched images are so delicate that the greatest care has to be taken not to lose or injure the most delicate half-tones. The etching process seems likely to be most useful for line work, and has already been applied successfully to the production of some of the new district and provincial administration maps, for the illustration of reports, &c.

The following is a description of the new process as worked out by Mr. Turner.

The negative should be of good quality, giving a good brilliant silver print. It should not be reversed.

The first thing to be done is to get a transparency from the negative, and upon the quality of this transparency much of the success of the process depends. The best method of obtaining the transparencies seems to be by taking a pigment print from the negative with the ordinary autotype tissue and developing it upon a plate of glass coated with collodion. The image thus obtained is intensified with permanganate of potash. By modifying the exposure and intensification, good transparencies may be obtained from apparently unsuitable negatives. The transparency should be strong, with clear glass in the highest lights, so as to bear from 20 minutes to half an hour's printing in the shade, and upon development leave almost clear copper in the deepest shadows. For line subjects the exposure necessary to obtain a good transparency is from 3 to 5 minutes in the sun. If, however, there should be a tendency for the lines to leave the plate on developing, a shorter exposure should be given and intensity obtained afterwards. For half-tone subjects the exposure in the shade may vary from 15 minutes to half an hour, according to the density of the original negative. After development, the gelatine image is intensified with a 1 per cent. solution of permanganate of potash, poured on and off till sufficient intensity is obtained, and after washing away all the permanganate, is treated with spirit of wine and dried off.

The next operation is the preparation of the copper plate for receiving the negative pigment print. The plate, having been thoroughly polished, receives a coating of finely powdered bitumen, which forms a grain upon it. For this purpose a large box with a lid is used; a quantity of bitumen very finely powdered is placed in it and blown about with a bellows so as to produce a cloud of dust inside the box. As soon as the coarser particles have subsided, the plate is placed inside the box, the lid being closed, and allowed to remain for 5 or 10 minutes, to allow a sufficient quantity of dust to deposit itself, according to the density of grain required, which is much greater for half-tone subjects than for line work. The nature and perfection of this grain have a great influence on the picture, and some experience and care are required to obtain satisfactory results. Should sufficient dust not be deposited at first, the operation may be repeated.

This loose deposit of powdered bitumen must now be fixed, so that it may remain firmly attached to the plate and not be liable to be rubbed off. One way of doing this is by heating the plate evenly all over until the bitumen is almost melted. Mr. Turner adopted an ingenious method which he considers preferable to heat. Sufficient benzole is poured into a flat dish to cover the bottom of it, and the plate is laid face downwards on two supports about half an inch above the surface of the benzole. The dish is covered over, and the plate left exposed to the fumes of the benzole for about 2 or 3 minutes, the time depending on the distance of the plate from the liquid. When the grain is fixed, the surface of the plate will have lost its dull powdery appearance and be semi-brilliant, while rubbing with the finger will not remove the deposit. The exposure to the benzole should not be too much prolonged, otherwise the grains lose their sharpness. I have found that fuming with oil of lavender is also very effective, and seems to give a sharper and finer grain, though it takes about half an hour to produce the proper effect. In warm weather 15 minutes suffices.

When the grain is fixed, the plate is placed in clean cold water and allowed to remain till the negative print is ready for development upon it. It will be found that after soaking

for some time all greasiness is removed from the plate. I have found that the same effect may be produced more quickly by flowing the plate over with spirit of wine, and it is advantageous in other ways to do so before placing it in the water, when the oil of lavender is used for fuming.

There are other ways of obtaining a resinous grain on the copper plates as employed by aquatint engravers, which would probably answer well, but we have not yet tried them.

A pigment print is next taken from the transparency on the ordinary autotype tissue (standard brown) and developed in the usual way on the prepared copper plate. This gives a negative image on the plate, and considerable care is required in developing, because the lights and shadows being reversed, it is difficult to know when to stop the development. The deepest shadows should show bare copper, and the lights must be quite free of all soluble gelatine, which is best accomplished by slow development with water at a moderate temperature. As the parts of the film forming the lights of the picture are thicker than is usually the case, great care must be taken to keep them adherent to the copper during development in warm weather.

After development the image is flowed over with a 5 per cent. solution of alum and dried off with spirit of wine. This clears up the shadows, and gives a sharper and crisper image than is obtainable by drying spontaneously. It is well to begin with weak spirit containing about equal parts of water and spirit, flowing it over the plate from one corner, so as to drive before it the water in the film, together with the scum which the spirit forms with any loose soluble gelatine remaining on the surface. After treatment with stronger spirit till all moisture is removed, the plate is finally flooded with a solution of—

Glycerine	1 part
Spirit of wine	20 parts.

and left to dry. This last treatment is only necessary in dry weather to prevent the splitting off of the film on drying.

When dry, the plate is ready for etching. The borders of the plate all round the picture are painted with black varnish, and the back of the plate may also be painted with it. The varnish being dry, the plate is placed in a dish and covered with a solution of perchloride of iron and water in equal parts with one-fourth of alcohol added. This immediately attacks the deepest shadows where there is little or no gelatine, then gradually penetrates the half-tones, and ultimately the thicker parts of the film forming the lights of the picture; the highest lights should remain unattacked. It is difficult to estimate the time required for etching the image, but 4 to 5 minutes is usually sufficient for half-tone subjects printed from a good dense transparency. With practice the progress of the etching may be watched, and stopped as soon as it is seen that the high lights are reached, though this is difficult on account of the dark colour of the film.

As soon as the plate is considered sufficiently bitten, the gelatine is quickly washed off under a strong stream of water. Should there be any difficulty in removing it, a little bicarbonate of soda rubbed on it will soon clear it off. Care must be taken not to allow time for the water to penetrate the film, otherwise the high lights will become etched. When clear of gelatine, the plate is dried, and the black varnish cleaned off the back and edges with benzole. The plate is then carefully cleaned with tripoli or other soft polishing powder which brings out the image, and is ready for printing.

Should the plate not be bitten deep enough, it may be improved by skilful rebiting, as practised by aquatint engravers. Mr. Turner's method, with which he was very successful, is as follows.

The etched plate is rolled in carefully with an India-rubber lithographic roller (Lanham's patent), charged with a composition made of—

Hard retransfer ink	2 parts.
White wax	1 „
Cocoanut-oil sufficient to allow the roller to work easily.	

The roller is prepared with a hard and almost dry layer of the above ground, and is applied to the plate with considerable pressure, till a thin layer of the same is transferred to the plate. When evenly and sufficiently coated, the plate is heated to melt the composition. Great care must be taken at this stage that none of the fine work gets clogged, and at the same time sufficient of the resist should be applied to allow an application of the etching fluid for a second or two. After this slight rebiting a rather thicker coat of the resist can be applied without danger of clogging, and the etching fluid allowed to act longer. This process of coating the plate with the resist, heating, and etching is continued, increasing the time of rebiting each time till the image is of sufficient strength for printing.

This method of rebiting has also been utilized with great advantage in repairing some of the old and worn-out plates of the Atlas of India. By stopping out the names and other details not required to be bitten, after the plate has been rolled in with the resist composition, and allowing the etching fluid to act on the worn-out hill portions for only a minute or two, an amount of work may be done in a few days that would take an engraver months to go over by hand.

Much of the work done by the new process has been experimental, but three good plates of Indian art-work have been done by it, and nine plates of the district maps. For the latter the rebiting process was of great service in getting the requisite printing depth.

Nine plates of half-tone subjects, among them one 20″ × 18″ for the award certificate of the Exhibition, have been produced during the year by the electrotyping process, but since the introduction of the etching method the electrotyping has rather gone out of use. It is, however, a valuable process, and I propose to continue working it as well as the new method.

Exhibition.—Notwithstanding the fire which occurred just at the time that preparations were being made for the Exhibition, and by which many of our best specimens were destroyed, the office was able to exhibit a large and representative collection of examples of the various kinds of work executed by photozincography, silver-printing, heliogravure, and collotype, and the practical working of these photo-mechanical processes was illustrated as far as it could be by series of specimens showing the different intermediate stages of the operations in each. For these specimens a gold medal was awarded to the office.

A good deal of other work has been done in connection with the Exhibition. Under my superintendence, Mr. Turner took about 200 negatives of the best specimens of Indian art-ware and views of the Exhibition for the Government of Bengal, of which ten sets have been printed by ordinary silver-printing. Many of the subjects have also been reproduced by the collotype and heliogravure processes for practice, and with a view to subsequent publication. The gold medal award certificates were all printed by collotype, and the silver and bronze medal and 3rd, 4th, and 5th class certificates were printed in the copper plate printing section of the Engraving Office from the heliogravure plate prepared here. The total number of copies printed from the latter was 3,500.

A good deal of my time and leisure were taken up in drawing up new plans of buildings for the accommodation of the Lithographic and Photographic Offices, and this and other calls on my time in these two offices have prevented me from devoting so much time as I have usually done to the practical working and improvement of the various processes pursued in the office. There was, however, the less necessity for it, as I had the benefit of the services of Messrs. Turner and Haward for this purpose. At the end of the year, after the office had closed for the Doorga Poojah holidays, I proceeded on a tour of inspection to the field parties in recess at Naini Tal and Mussooree, and also visited Simla. My proceedings on this tour will more properly be noticed in next year's report.

B.

Comparative Statement of the Outturn of 1883-84 *with that of the previous year*

	Ordinary Work.				Cadastral Maps.			
	1st October 1883 to 30th September 1884.	1st October 1882 to 30th September 1883.	Difference.	Difference in square inches.	1st October 1883 to 30th September 1884.	1st October 1882 to 30th September 1883.	Difference.	Difference in square inches.
Originals	941	1,152	−211	.....	5,202	5,113	+89	.....
Negatives	1,869	2,040	−171	.....	2,978	3,462	−484	.....
Ditto, square inches	626,359	590,681	.....	+35,678	2,255,802	2,628,816	.....	−372,914
Photographic transfers	1,929	1,937	−8	.....	2,995	3,629	−634	.....
Ditto, square inches	670,202	588,880	.....	+81,322	2,323,798	2,687,066	.....	−363,268
Silver-prints	2,214	581	+1,637	.....	.....	.....	.....	.....
Ditto, square inches	230,184	141,726	.....	+88,460	.....	.....	.....	.....
Collotype prints	3,313	.....	+3,313	.....	.....	.....	.....	.....
Heliogravure plates	23	.....	+23	.....	.....	.....	.....	.....
Transfers to zinc (plates printed)	713	977	−264	.....	5,083	5,174	−91	.....
Number of pulls	99,210	129,984	−30,774	.....	122,544	129,369	−6,825	.....
Ditto of printed sheets (single)	153,844	321,894	−168,050	.....	122,544	129,369	−6,825	.....
Ditto ditto (combined)	113,452	286,785	−173,333	.....	55,374	55,344	+30	.....
Proofs	1,337	1,401	−164	.....	5,240	5,027	+213	.....
Transfers	1,025	1,174	−149	.....	5,407	5,214	+193	.....

C.

Statement showing the Amount and Value of the work done for other Departments and despatched between 1st October 1883 and 30th September 1884.

	Number of original sections.	Number of negatives.	Number of pulls.	Number of complete copies.	Silver and other prints.	Collotypo prints.	Value.
							Rs. A. P.
Asiatic Society	3	3	1,463	1,463	.....	.....	127 9 6
Adjutant, Presidency Volunteers	5	.....	4,000	3,200	.....	.....	630 2 11
Agents, Darjeeling-Himalayan Railway ...	.....	.....	12	12	.....	.....	3 0 0
Calcutta International Exhibition Committee ...	3	5	810	2,310	15	1,163	755 6 5
Curator of Ancient Monuments	16	16	3,100	21,000	.....	.....	737 14 8
Chief Engineer, Bengal, Public Works Department.	50	150	5,194	4,654	.....	.....	4,123 7 0
Chief Engineer, Irrigation Branch, Public Works Department, Punjab.	38	24	2,500	3,000	.....	.....	1,001 9 0
Director of Garrison Instruction in India ...	2	2	200	500	.....	.....	157 9 11
Director-General of Railways	1	4	2,000	2,000	.....	.....	511 5 11
Ditto of Telegraphs in India... ...	2	2	1,250	2,500	.....	.....	178 3 3
Eastern Bengal Railway	16	21	975	900	.....	.....	465 12 0
Foreign Department	1	1	50	50	.....	.....	67 6 0
Government of India, Military Department ...	6	3	158	163	.....	.....	84 11 1
Government of India, P. W. ,, ...	39	23	2,416	4,125	.....	.....	993 9 7
Government of India, R. and A. ,, ...	2	2	400	640	.....	.....	58 14 9
Government of Bengal, P. W. ,, ...	23	72	4,400	6,540	.....	.....	1,512 10 2
Government Architect	6	18	550	750	.....	.....	254 9 4
Inspector-General of Military Works	85	185	5,485	5,035	.....	.....	4,096 0 10
Junior Secretary to the Chief Commissioner, British Burmah.	1	4	210	100	.....	.....	112 16 6
Mayo School of Arts, Lahore	10	.....	.....	.....	44	.....	23 12 0
Meteorological Reporter to the Government of India.	4	4	1,930	320	.....	.....	267 14 3
Manager, Rajputana and Malwa Railway ...	5	.....	1,900	1,900	.....	.....	331 3 2
Port Officer, Calcutta	1	1	150	150	.....	.....	29 3 6
Port Commissioners, Calcutta	44	127	5,355	5,165	.....	.....	3,099 10 3
Provincial Gazetteer, North-Western Provinces	7	5	2,163	2,153	.....	530	453 7 0
Quarter-Master-General in India	26	26	6,332	7,120	.....	.....	1,763 13 5
Sanitary Commissioner, Assam	1	.....	500	250	.....	.....	94 11 3
Settlement Officer, Pegu and Hanthawaddy ...	1	1	503	1,004	.....	.....	117 3 0
Superintendent, Government Printing, Bengal...	1	1	625	5,000	.....	.....	85 2 6
Ditto ditto ditto India ...	1	1	104	104	.....	.....	24 8 6
Ditto of Stationery	.....	.....	263	263	.....	.....	44 14 0
Ditto of Geological Survey of India ...	6	9	2,240	2,240	172	.....	544 2 3
Ditto of Carriage and Wagon Department, East Indian Railway.	4	13	160	160	.....	.....	253 2 8
Ditto, Way and Works, Rajputana and Malwa Railway.	31	44	1,000	1,250	.....	.....	329 13 3
United Service Institution, Simla	.....	.....	.....	.....	.....	250	31 8 0
Colonel Tanner	5	5	20	20	11	.....	70 15 6
R. H. Wilson, Esq., C.S., Midnapore	2	2	.....	.....	4	.....	2 8 0
Major R. V. Riddell, R.E.	1	1	.....	.....	1	.....	31 4 0
Colonel Roberts	2	.....	.....	.....	9	.....	7 8 0
Dr. G. King	2	2	12	12	.....	.....	10 0 0
J. F. Fleet, Esq.	1	2	.....	.....	2	.....	15 10 0
G. G. Palmer, Esq.	.....	.....	.....	.....	4	.....	2 8 0
Total ...	371	791	58,708	86,526	261	1,993	24,568 6 4
Cadastral, N.-W. Provinces photozincographs	554	556	9,740	5,079	.....	.....	15,122 5 0
Ditto, ditto zincographs ...	906	.....	9,596	7,724	.....	.....	9,438 12 0
Ditto, British Burmah photozincographs	1,165	1,164	32,235	18,852	.....	.....	18,696 11 0
Ditto, ditto zincographs ...	502	.....	17,068	7,090	.....	.....	5,516 2 0
Ditto, Bengal photozincographs	529	529	33,152	7,610	.....	.....	15,053 8 0
Ditto, ditto zincographs ...	712	.....	31,238	11,423	.....	.....	11,390 12 0
Total Cadastral ...	4,909	2,840	140,651	58,821	.....	.....	75,358 2 0
GRAND TOTAL ...	5,331	3,631	199,359	145,147	261	1,993	97,926 8 4

D.

Statement of Expenditure of the Photographic Office, Survey of India Department, during the Survey year, from 1st October 1883 to 30th September 1884.

	Rs. A. P.	Rs. A. P.
NORMAL ESTABLISHMENT.		
Superintendent's salary	10,400 0 0	
Establishment	23,320 9 7	
Office rent and taxes	4,659 14 0	
Contingencies	1,796 15 5	
		45,177 15 0
CADASTRAL ESTABLISHMENT.		
Establishment	33,828 11 9	
Office rent and taxes	2,769 5 3	
Contingencies	7,696 1 8	
		44,294 8
Chemicals and stores received from England	22,539 2 9	
Paper received from England	9,672 1 9	
		32,211 4 6
Stores received from the Mathematical Instrument Office	136 9 9	
Cost of repairs of articles at Mathematical Instrument Office	333 15 0	
		470 8 9
Paper received from the Lithographic Office	2,001 13 9	
Miscellaneous stores received from other offices...	94 11 4	
		2,096 8 2
Paper and map cloth from the Stationery Office	2,123 4 0	
Miscellaneous stores from the Stationery Office	69 5 7	
		2,193 9 7
Work done by the Foundry and Shell Factory and by Public Works Department	176 9 9	
Lithographic presses received from the Superintendent, Government Printing, Allahabad	1,023 7 4	
Shipping and landing charges incurred by the Marine Department	99 4 0	
		1,299 5 1
Total. ...	.....	1,27,763 5 0

Statement showing the amount credited during the Survey year, from 1st October 1883 to 30th September 1884.

	Rs. A. P.	Rs. A. P.
Standard maps and other maps and plans issued to the Survey of India Office	23,267 1 6	
Miscellaneous work done for the other branches of the head-quarter office	698 14 9	
		23,966 0 3
Miscellaneous maps and plans, extra departmental...	24,463 6 4	
		24,463 6 4
Cadastral maps, North-West Provinces	22,561 1 0	
Cadastral maps, British Burma ...	24,312 13 0	
Ditto, Bengal	26,484 4 0	
		73,358 2 0
Old tin and packing cases sent to Mathematical Instrument Office.	172 1 0	
Articles and stores supplied to other branches	431 11 1	
		603 12 1
Sale of unserviceable articles ...	229 6 9	
Pure silver recovered from silvered paper and collodion films ...	3,833 0 5	
		4,062 7 2
Articles supplied to Government Printing Office	54 0 0	
		54 0 0
Balance against the department ...	.....	1,159 9 2
Total ...	.....	1,27,763 5 0

rative Report of the Trigonometrical Branch Office, Survey of India, for the 12*-month ending* 30*th September* 1884.

THE following changes took place during the year under report:—

Lieutenant W. H. Pollen, R.E., was appointed Assistant Superintendent, 2nd grade, and ed to this office on 26th April 1884, and Lieutenant S. G. Burrard, R.E., was appointed istant Superintendent, 2nd grade, and posted to the office on the 2nd September 1884. newly-passed candidates, viz. Messrs. H. A. Charrier and C. G. S. Wood, Assistant veyors, 3rd grade, were posted for instruction to the office from 21st April and 12th gust 1884, respectively; and Mr. W. W. McNair, Surveyor, 4th grade, from 17th August, the view of his bringing up his report on his late explorations. One computer resigned st December 1883, and another was entertained on 3rd March 1884. One compositor was pointed on 5th March 1884. One apprentice draftsman died on 17th October 1883, another gned on 2nd December 1883, and a third was discharged on 7th January 1884, and three rentice draftsmen were entertained. Manrakhan, head artificer, after a highly meri- bus service of about 20 years, was placed on an invalid pension from 4th April 1884, and matullah was entertained in his place on 4th August 1884.

The following cost-table of work done in the computing branch is in similar form hat given for last year:—

Cost-table in Rupees.

CLASS.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Average per cent.
Records	56	24	19	28	20	31	76	53	53	59	40	42	2
Computations	315	452	343	461	554	463	411	334	451	459	420	510	18
Account, returns, correspondence	593	531	418	554	504	546	530	595	629	605	631	752	23
Supply	53	31	27	43	50	66	25	81	90	44	58	87	2
Press copy	335	428	267	256	196	163	317	278	392	227	197	343	11
Press proofs	217	236	157	201	336	264	287	345	282	273	211	245	10
Charts	...	23	65	60	65	...	...	...	25	...	7	3	1
Stations	58	63	21	77	130	136	81	93	92	126	135	61	4
Leave and vacations	425	157	700	346	324	279	442	261	102	242	239	217	13
Miscellaneous	137	156	156	115	122	244	158	314	275	268	546	264	9
Meteorology and general science	241	230	200	222	56	223	105	191	146	239	135	69	7
Total ...	2,437	2,437	2,363	2,362	2,302	2,422	2,422	2,543	2,542	2,542	2,619	2,603	100

The percentage this year under classes 2 and 5, viewed collectively, is again considerably below that for the year 1881-82, and is, moreover, 2 per cent. below that for last year. This decrease is in a great measure due to two causes: *first*, to increments under classes 3 and 10 consequent on the diversion to a considerable extent of the services of Mr. C. Wood to the current duties of the office of the Deputy Surveyor-General; and *secondly*, to Mr. Peychers having been employed for about a month in the preparation of the equipment for the survey party to accompany the Afghan Boundary Commission. The decrease under class 11 is due to the cessation of actinometric observations.

The particulars of the work done, indicated in a general manner in the preceding table, are given hereafter in such detail as appears desirable.

CLASS II.—COMPUTATIONS (IN DUPLICATE).

South-West Quadrilateral.—This is the last section of the principal triangulation of India remaining for final reduction. Certain preliminary calculations in connection with the reduction have been made as opportunity offered, embracing—

Triangles computed up to Log. feet	208
Ditto ditto Log. sines	50
First deductions of λ, l and A (real traverse)	33
Ditto ditto (check traverse)	28

Southern Trigon.—The calculations connected with the final reduction of the principal triangulation having been completed and the data being in course of compilation for the press, the secondary triangulation, which, together with Colonel Lambton's triangulation of Southern India, forms a large and intricate mass, can now be taken in hand. A small commencement with some of the outlying portions has already been made.

Malabar and Coimbatore Series.—Computed 60 triangles, 27 first and 16 second deductions of λ, *l* and **A**.

Coringa Series.—Adjusted and computed 55 triangles and 77 deductions of λ, *l* and **A**.

Masulipatam Series.—Computed 60 triangles, 1 traverse of 15 stations, and 55 deductions of λ, *l* and **A**.

North-West Quadrilateral.—The Jodhpore and Eastern Sind Series are two chains of triangles appertaining to the North-West Quadrilateral. They were executed subsequently to the final reduction of that Quadrilateral. The principal triangulation was reduced prior to the year under report. The secondary triangulation is now also nearly disposed of. The calculations performed during the year have been :—

Jodhpore Meridional Series.—Secondary triangulation. Computed 15 deductions of λ, *l* and **A**.

Eastern Sind Meridional Series.—Secondary triangulation. Computed 4 traverses of λ, *l* and **A**, 102 ordinary deductions, and 16 first, 16 second, and 16 third deductions of λ, *l* and **A** : 209 triangles have been adjusted and computed, and 101 computed only: vertical angles of the Joysulmere Minor Series have been deduced and corrected for disbevelment error.

Burma Secondary Triangulation.—(Executed by Moung Shoay Gyoke). Computed 44 triangles, 30 deductions of λ *l* and **A** and 90 deductions of heights, and both the horizontal and vertical angle books were examined.

Survey Detachment in Kashmir.—This detachment consists of a sub-surveyor and a small native establishment. The sub-surveyor both surveys with the plane-table and takes angular observations with a theodolite, but he was unable to work out the latter in the field, and his time in recess was fully occupied in preparing his fair map: hence the necessary calculations had to be performed in this office; they were as follows :—Adjusted and computed 241 triangles, and computed 143 deductions of λ, *l* and **A** and 101 deductions of heights; lengths and azimuths of 86 sides computed from the λ and *l* of their extremities; positions of 31 points determined from observations to three known points; also the horizontal and vertical angle books brought up and otherwise completed. This work engaged a pair of computers for nearly 3 months.

Andaman Island Survey.—Computed a portion of the observations for azimuth at Chatham Island to assist the officer in charge of No. 3 party, Andaman Topographical Survey.

Observed Latitudes.—Endeavours have been made to push on these calculations, it being at one time hoped that they might be brought to a conclusion before the retirement of Mr. Hennessey, under whom they have been directly carried on since they were commenced; but interruptions were unavoidable; and partly from having to aid another party with computing power, partly from sickness of one of the computers, and partly from other causes, the calculations are still far from complete. The work done during the twelve months was as follows :—

Data for determination of latitude, by each star, of 27 stations, have been deduced and abstracted from the original computations as last year, and latitudes computed therefrom. Deduced values of latitudes, by each star, have been abstracted for 95 stations in a table as last year. A table has been made showing the errors on the mean latitudes of stations by each star and by means of which the adopted values of N. P. D. (or provisional place) are in course of being checked. Another table has been put in hand to compare the astronomical with the geodetical latitudes of 117 stations (including revisits) and to ascertain thereby the deflections of the plumb lines. With a view to prove the identity of the latitude stations with the geodetic, the original records have been looked into for the necessary information, and their identity, with few exceptions, established. The services of the two pairs of computers engaged on this work could not be employed on it for more than five months.

Electro-telegraphic Longitude.—The computations were done entirely under Major Heaviside's supervision; they appertained principally to season 1883-84; he was assisted for 2¼ months by two computers.

Spirit-levelling.—Levels between Calcutta and False Point were examined and the errors of three circuits were obtained.

Auxiliary Tables.—Tables I, II, VI, XVII, XVIII and XXVI were extended from lat. 36° to 40° for the use of the Afghan Boundary Survey Party.

Captain Barrow's Barometrical Observations in Nepal.—Thirty-three deductions of heights from aneroid observations were computed.

Class 3.—Accounts, Returns, Correspondence.

A portion of the work embraced in this class is of a purely professional nature, but the class also embraces the current work of the office of Deputy Surveyor-General, Trigonometrical Branch, as no special establishment has been yet provided for that office.

Class 4.—Supply.

Requisitions from over 24 officers, for data of various kinds, have been complied with. Some of them involved a good deal of labour and calculation; 1,072 despatches of maps, charts, books, forms and Survey of India Department notes (January to August) have been made during the year.

Class 5.—Press Copy.

North-East Quadrilateral.—Synoptical Volume XXI was completed in respect to preface, table of contents, errata *et* addenda, and reference tables. Assam Longitudinal Series. Co-ordinate lists of stations and points grouped in square degrees were prepared.

Southern Trigon.—The compilation of the descriptions of the principal stations for publication has been proceeded with. Abstracts of heights of principal stations have been made for the South-East Coast and Mangalore Meridional Series in part, and for the South Konkan series in full. Triangles of the Great Arc Series, section 8°—18°, have been corrected up and azimuths abstracted in part, and heights in full. Computations of observed azimuths of the Madras Meridional and Coast Series have been examined.

South-East Quadrilateral.—The introduction of the South Pārasnāth Series has been finished, and an abstract of the non-circuit triangles of the South Pārasnāth and South Mālunchа series, showing the details of their final adjustment, was prepared.

North-West Quadrilateral.—The azimuth and co-ordinate lists of the Jodhpore Series were partly prepared for the press. The introductions for this and the Eastern Sind Series were kindly written by Major Rogers while on leave at Mussooree. The observed angles of the Eastern Sind Series were arranged and compared; also the abstracts of the calculation of heights of principal stations, of the figural reductions, and of the observed azimuths. For the Synoptical Volume of the same series, azimuth and co-ordinate lists were prepared in part, and a portion of the secondary triangles.

Electro-telegraphic Longitude operations.—Examined press copy for season 1881-82.

Miscellaneous.—Descriptions of stations for revised preliminary charts of the Burma Triangulation, seasons 1877-80, compiled. Routes in Western Himalayas (new edition):—Revised and corrected Polymetrical Table No. I; Tables II and III are in hand. Spirit-levelled pamphlets:—Adjusted levels of bench marks between mean sea-level at Bombay, Madras, and Karwar for a revised edition of these levels. Survey of India Department notes supervised through the press.

Class 7.—Charts.

Spirit-levelled chart, Calcutta to False Point, seasons 1881-83, examined and corrected. Revised preliminary chart of Burma Triangulation, seasons 1877-80, compared and finally examined. Burma Secondary Triangulation Chart, seasons 1875-77 and 1879-81, compared. Revised sheets Nos. 1 to 3 of A—K's explorations, examined. Entered numerals of stations, triangle numbers, &c., in two copies of rough reduction chart of the South-West Quadrilateral, and prepared a rough working chart of the Joysulmere Minor Series.

Class 8.—Stations.

The subjoined table is similar to that given in the reports for the two preceding years. During the year under report 55 new stations have been added, including 15 beacons (on the east coast of India) specially erected and their positions fixed for the benefit of the Marine Survey Department. There were 865 stations repaired at an average of Rs. 4-1 (against Rs. 4-3 per station in the previous year). The number of officers who have not reported during the year is ten less than before, but every endeavour will be made during the ensuing year to make special application to those whose reports are in arrears.

Number of stations.	Number of districts in which stations occur.	Number of lists in which stations are included.	Duplicate (i. e. finally disposed of) lists.		Number of lists sent out from this office during the current year.		Number of Local Officers who have—		Number of stations spoiled during the year.	Number of bills audited and passed.	Total cost.	Average cost per station for repairs.	Number of letters, packets, &c., issued.
			Number of lists.	Number of stations included.	New.	Supplementary.	Reported during the year.	Not reported during the year.					
3,599	330	317	311	3,522	.....	3	249	68	55	212	Rs. 3,511	Rs. a. 4 1	About 330

Class 10.—Miscellaneous.

Great Trigonometrical Survey Synoptical Volumes.—Volumes XIX, XX and XXI: Pages examined and collated; distribution lists prepared and presentation labels written and inserted in Synoptical Volumes XVII to XXI. Transcription of Library Catalogue proceeded with. Mergui Base-line:—Introduction and General Narrative transcribed in one copy and

explanatory notes compared; data for projection of plates prepared. Fifteen candidates for the Junior Branch of the Survey Department examined. A set of examination papers in Astronomy for the Senior Branch prepared. Sixty-eight sets of observations, both to the sun and stars (on 18 days) for determination of local time taken and reduced, and the rating of chronometers and clocks attended to as usual. Lieutenant Pollen, R.E., Assistant Superintendent, and Messrs. H. Charrier and C. G. S. Wood, Assistant Surveyors, received professional instruction. The book of routes in the Madras Presidency (by the Quarter-Master-General's Department) was corrected up to date. All instruments required for the equipment of the Survey Party to accompany the Afghan Boundary Commission were thoroughly cleaned, adjusted, compared and otherwise tested, and suitable mule-trunks were made up for their transport. The klassies for the party had also their wants attended to in respect to warm clothing, &c. In fact the whole party was completely equipped at this office.

Class 11.—Meteorology and General Science.

Meteorological observations.—No change has been made on the procedure of former years. The results of the observations taken at Dehra Dún twice daily throughout the year have been supplied to the Meteorological Reporter to the Government of the North-Western Provinces and Oudh, daily weather telegrams were sent from Mussooree to Simla during the six months the office was open at Mussooree, and anemograms for Mussooree for six months and for Dehra for twelve months have been furnished to the Meteorological Reporter to the Government of India. The usual tables of monthly results and of the mean velocity of wind at Dehra are appended. Another nine months' observations of deep-sunk earth thermometers have been added. The table of monthly means given in last year's report has accordingly been extended to 30th September 1884. The table has been altered in arrangement to enable a ready comparison to be made.

Mean Monthly Readings of Deep-sunk Earth Thermometers.

Depths in feet of thermometer bulbs below surface of ground.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
25·6	1881	.....	.....	.....	.....	.....	75°·55	75°·20	75°·02	76°·07	76°·09	76°·08	76°·71
	1882	75°·91	75°·13	74°·52	74°·11	73°·97	74°·05	74°·31	74°·35	75°·03	76°·14	76°·39	76°·37
	1883	76°·83	75°·62	74°·28	73°·89	73°·37	73°·36	74°·32	74°·30	75°·08	76°·16	76°·23	76°·12
	1884	75°·20	74°·29	73°·90	72°·66	73°·65	73°·93	74°·51	76°·00	76°·87	.....	.....	.....
12·8	1881	.....	.....	.....	.....	.....	74°·87	76°·47	77°·58	78°·93	79°·26	77°·71	74°·89
	1882	72°·38	70°·79	70°·47	71°·70	73°·37	75°·23	76°·57	76°·20	78°·05	79°·02	77°·44	74°·59
	1883	72°·46	70°·36	69°·52	70°·24	73°·00	73°·17	76°·52	76°·30	78°·07	78°·26	76°·93	73°·50
	1884	70°·93	69°·75	68°·64	71°·42	73°·39	73°·75	77°·32	79°·24	79°·82	.....	.....	.....
6·4	1881	.....	.....	.....	.....	.....	80°·66	81°·01	80°·75	81°·24	80°·33	76°·80	70°·58
	1882	61°·17	66°·06	69°·76	72°·29	76°·47	80°·01	80°·78	81°·30	81°·32	80°·16	75°·76	71°·05
	1883	61°·61	65°·10	66°·48	71°·08	76°·72	79°·29	80°·70	81°·42	81°·13	79°·50	74°·60	69°·71
	1884	66°·03	63°·61	62°·96	72°·35	76°·60	80°·76	81°·56	81°·64	81°·10	.....	.....	.....
3·2	1881	.....	.....	.....	.....	.....	85°·93	81°·29	82°·03	82°·40	79°·67	72°·20	65°·63
	1882	62°·52	62°·31	67°·61	75°·49	80°·81	81°·77	82°·71	83°·04	82°·20	79°·21	71°·73	66°·14
	1883	62°·27	60°·70	64°·83	74°·13	81°·57	83°·41	83°·00	83°·43	81°·74	76°·23	69°·72	62°·50
	1884	61°·23	61°·90	67°·69	76°·75	82°·32	83°·11	83°·20	84°·94	81°·33	.....	.....	.....
1·1	1881	.....	.....	.....	.....	.....	85°·16	84°·14	83°·55	83°·19	77°·81	67°·81	60°·72
	1882	58°·91	59°·41	60°·60	76°·58	84°·59	85°·24	83°·43	84°·05	83°·80	77°·85	67°·96	62°·27
	1883	57°·96	58°·45	63°·87	79°·33	86°·65	87°·94	84°·55	84°·89	82°·19	76°·70	65°·41	57°·83
	1884	58°·28	59°·89	69°·56	80°·14	85°·27	86°·97	83°·59	85°·03	81°·64	.....	.....	.....
Thermometer in shade	1881	.....	.....	.....	.....	.....	87°·68	82°·54	81°·09	82°·86	81°·72	76°·22	71°·19
	1882	66°·77	66°·51	81°·36	88°·72	91°·04	89°·11	81°·61	82°·40	84°·62	83°·47	75°·04	72°·36
	1883	64°·80	63°·72	75°·59	91°·83	95°·64	90°·60	83°·54	83°·83	82°·36	82°·60	70°·93	66°·12
	1884	67°·36	65°·32	81°·32	89°·51	97°·33	89°·69	85°·86	79°·75	66°·30	.....	.....	.....

A—K's explorations in Great Tibet and Mongolia.—Translation of his diary examined and corrected. Tables of observed latitudes and boiling point heights prepared and those of air-temperatures, population, &c., also a vocabulary of certain Tibetan and other words, occurring in the report, compiled.

Sub-Surveyor Ahmad Ali's account of Dardistan translated into English.

Actinometry.—As reported last year, Sergeant Rowland and his assistant started from Dehra on the 3rd October 1883 for Leh; since then no further observations have been taken at Mussooree. A batch of six thermometers was received in November 1883, and remains in store.

TYPOGRAPHIC BRANCH.

The usual table showing the work annually performed by this branch during the past five years is given below, the unit (a page of foolscap) being the same throughout:—

	1879-80.	1880-81.	1881-82.	1882-83.	1883-84.
Pages composed	1,421	1,363	1,283	1,381	1,498
,, printed	494,136	480,672	471,616	475,586	362,386

An analysis of the pages composed furnishes the following:—

		Pages.
Of Professional Volume ...	Longitude Volume	143
	Eastern Sind Series	58
	Jodhpore Series	129
	S. Párasnáth and S. Málúncha Series ...	78
	Southern Trigon	97
	Total ...	505
Of Synoptical Volume ...	Assam Longitudinal Series	33
	Volumes XIX and XX	9
	Volume XXI	20
Of North Afghanistan Triangulation		6
,, Spirit-levelled Heights, Southern India		32
,, Spirit-levelled Heights, Calcutta to False Point		77
,, Notes on the Preliminary Actinometrical Operations at Leh		76
,, Account of Tidal Disturbance owing to volcanic eruption at Java ...		34
,, Survey of India Department Notes		61
,, Report on Kafiristan		22
,, Description of Dardistan		12
,, Auxiliary tables		3
,, Report on A—K's explorations in Great Tibet and Mongolia (including a portion of the reprint for final publication)		220
,, Charts, orders, memoranda, forms, &c.		351
For Forest Department		37
	Total ...	993

The outturn of the printed pages during the year is considerably below that given for preceding years, and is due chiefly to the small number of copies struck off in several cases, such as the prints of A—K's diary and other reports of explorations, of which only a few preliminary copies were printed for submission to the Foreign Office; also to the fact that only 200 copies (reprint) of the Jodhpore Meridional Series Professional Volume were struck off to bring up the number to 500; also a pamphlet on the Actinometric Observations, of which but 30 copies were printed; and the Survey of India Department Notes. The total decrease due to these accounts for fully over 11,000 pages, so that the smaller number of prints this year is due entirely to the limited number of copies required of no less than 500 pages, or about one-third of the total number of pages composed.

PHOTO-ZINCOGRAPHIC BRANCH.

The following are the particulars of the work executed by the Photo-zincographic Branch during the year:—

MAPS.

SUBJECT.	When published.	Number of parts.	Number of sheets printed.
Prints of maps published in former years	.....	29	4,649
Sketch map of routes traversed by European and Asiatic explorers beyond the British frontier (1865-83)	October 1883	1	254
Map of passes from Bannu into North Waziristan	,, ,,	1	185
Guzerát Survey, Sheet No. 49, Section 16 (*Dang Forest*) ...	,, ,,	1	88
Ditto ditto ,, 49 ,, 7 2*nd Edition* (*Dang Forest*)... ...	November ,,	1	86
Ditto ditto ,, 49 ,, 8 2*nd Edition* (*Dang Forest*)... ...	,, ,,	1	85
Ditto ditto ,, 33 ,, 2	,, ,,	1	82
Ditto ditto ,, 33 ,, 4	,,	1	86

Subject.	When published.	Number of parts.	Number of sheets printed.
Nepal Boundary Trace No. 1	November 1883	1	27
Ditto ditto „ 2	„ „	1	28
Ditto ditto „ 3	„ „	1	27
Ditto ditto „ 4	„ „	1	28
Ditto ditto „ 5	„ „	1	28
Kumaun and Garhwál Forest Map, Sheet No. XXXVIII (*for Forest Department*)	„ „	1	70
Ditto ditto LXXVII (*for Forest Department*)	„ „	1	77
Ditto ditto XLIX (*for Forest Department*)	„ „	1	80
Ditto ditto LXXII (*for Forest Department*)	„ „	1	80
Sketch Map showing the Arbáb Lak route between the Upper Sind and Khozdar Valley	„ „	1	200
Index to the Guzerát Survey	„ „	1	728
Ditto Outch do.	„ „	1	744
Map of the sources of the Tavoy Rivers showing the boundaries of proposed state reserves, Sheet No. 1 (*for Forest Department*)	„ „	1	95
Ditto ditto 2 (*for Forest Department*)	„ „	1	95
Kattywar Survey, Sheet No. 5 (*2nd edition*)	December „	1	136
Ditto ditto „ 8 (*2nd edition*)	„ „	1	138
Guzerát Survey, Sheet No. 34, Section 3	„ „	1	85
Kumaun and Garhwál Forest Map, Sheet No. XXXVI (*for Forest Department*)	„ „	1	75
Bashahr Map, Upper and Lower (*for Forest Department*) ...	„ „	2	72
Map of the Gangotri Deodar Forests, Tiri-Garhwál (*for Forest Department*)	„ „	1	384
Guzerat Survey, Sheet No. 17, Section 1	„ „	1	80
Kattywar Survey „ 20 (*2nd edition*)	January 1884	1	136
Guzerát Survey, „ 34, Section 2	„ „	1	82
Ditto ditto „ 34 „ 4	„ „	1	86
Ditto ditto „ 36	„ „	1	178
Index Map of the Forest Survey of the Molghat Taluk, Berar (*for Forest Department*)	„ „	1	196
Sketch Map to illustrate A—K's explorations in Great Tibet and Mongolia, 1879-82, Sheet No. 2	„ „	1	726
Ditto ditto „ 3	„ „	1	727
Geological Map of the Mussooree Municipality with Landour and Rajpur, North-Western Provinces (*for Forest Department*) ...	„ „	1	554
Map of Deodar Forests at Mundáli, Dhárágád Valley, Jaunsár, North-Western Provinces (*for Forest Department*) ...	„ „	1	456
Index to the Sketch Map of A—K's explorations in Great Tibet and Mongolia, 1879-82	February „	1	728
Sketch Map to illustrate ditto ditto, Sheet No. 1 ...	„ „	1	723
General (Geographical Routes, &c.) Map to illustrate Tribal Settlements on the North-Western Frontier	„ „	1	352
Map showing changes in the Sunda Straits caused by the eruption of Krakatao	„ „	1	620
Plan of Lhása to accompany A—K's report	March „	1	106
Cutch Survey, Sheet No. 1	April „	1	131
Ditto, ditto „ 2	„ „	1	136
Ditto, ditto „ 6	„ „	1	130
Ditto, ditto „ 7	„ „	1	130
Ditto, ditto Nos. 8 & 9	„ „	1	130
Ditto, ditto No. 23	„ „	1	115
Guzerát Survey, Sheet „ 4C, Section 13 (*Dang Forests*) ...	„ „	1	80
Ditto ditto „ 4J „ 14 (*ditto*) ...	May „	1	91
Map of Bhopal and Málwa Survey (*for Major Wilmer*) ...	„ „	1	14
Kattywar Survey, Sheet No. 10 (*2nd edition*)	„ „	1	78
Revised Sketch Map to illustrate A—K's explorations in Great Tibet and Mongolia, 1879-82, Sheet No. 1	June „	1	660
Ditto *ditto* „ 2	„ „	1	710
Ditto *ditto* „ 3	„ „	1	439
Index to ditto (showing also sketch of the Jángthangi ...	„ „	1	624
Kattywar Survey, Sheet No. 10A (*2nd edition*)	July „	1	106
Skeleton Map of the district of Dehra Dún	„ „	1	24
Geological Map of India (*for Forest Department*)	„ „	1	340
Map of Chakrata Cantonment (*for N.-W. P. Gazetteer*) ...	August „	1	568
Kattywar Survey, Sheet No. 11 (*2nd edition*)	„ „	1	148
Maps for Foreign Office	„ „	7	590
Sketch Map of the country within 10 miles around Allahabad ...	September „	1	101
Kattywar Survey, Sheet No. 14 (*2nd edition*)	„ „	1	4
Totals ...	.....	100	19,808

In addition to the foregoing, 326 blue prints and 110 silver prints (13 subjects) were prepared for the Executive Officers.

Charts.

Subject.	When published.	Number of parts.	Number of sheets printed.
Northern Afghanistan Triangulation Chart, between latitudes 33° 0′ and 35° 0′ and longitudes 68° 0′ and 72° 0′ ...	October 1883	1	130
Preliminary Chart of the Aden Triangulation, season 1876-77 ...	December ,,	1	66
Cutch Triangulation Chart No. I	,, ,,	1	12
Ditto ditto ,, II	,, ,,	1	12
Ditto ditto ,, III	,, ,,	1	12
Eastern Frontier Series :—Final Chart	January 1884	1	395
Ditto Preliminary Chart, seasons 1877-78 and 1879-82	February ,,	2	130
Chart of spirit-levelling operations in Cuttack, Midnapore, Howrah, 24-Pergunnahs, the Sunderbuns and Hooghly districts of Bengal, No. 5, seasons 1881-82-83	May ,,	1	626
Total ...	.....	9	1,383
Diagrams.			
North-East Quadrilateral diagrams for volumes of the Great Trigonometrical Survey, tidal curves, &c., &c.	October 1883	.....	1,053
	November ,,	.....	1,762
	December ,,	.....	368
	January 1884	.....	1,682
	February ,,	.....	368
	March ,,	.....	1,026
	April ,,	.....	692
	May ,,	.....	723
	September ,,	.....	142
Total ...	.....	.....	7,815
Professional and office forms	.....	.....	25,590

Besides the above, 120 copies of 405 pages of the Janam Sákhi, or History of Guru Nának in Gurmukhi, were printed for the Punjab Government. This was a very difficult and laborious undertaking owing to the discoloured state of the paper, which was originally a light brown, but had become many shades darker from age and the unclean fingers of the students.

The total number of negatives taken was 778; the number of chromo-carbon prints 1,307, and the number of transfers to zinc, 181.

Contrasting the work performed since 1879-80, we have—

Year.	Maps.	Blue prints.	Silver prints.	Charts.	Diagrams.	Forms, &c.
1879-80	15,100	588	1,021	3,821	2,271	17,909
1880-81	15,659	414	52	1,886	3,367	19,508
1881-82	13,471	460	726	3,486	4,789	24,987
1882-83	12,300	278	105	2,441	10,495	30,195
1883-84	19,808*	326	110	1,383	7,815	25,590

An abstract of the work executed during the past five years stands thus :—

Subject.	Number of Prints.				
	1879-80.	1880-81.	1881-82.	1882-83.	1883-84.
Maps, charts, diagrams	21,192	20,912	21,746	25,236	29,006
Blue prints	588	414	460	278	326
Silver prints	1,021	52	726	105	110
Forms, &c.	17,909	19,508	24,987	30,195	25,590

The money actually realized and credited to Government from sales of maps, &c., during the year is Rs. 1,105-7-7.

* This great increase is due to a large number of A—K's maps having been printed.

DRAWING BRANCH.

Description of Work.	Number of Sheets or Diagrams.		Scale 1 inch = miles.	Remarks.
	Finished.	In hand.		
Final Charts.				
Assam Longitudinal Series	.....	1	4	For reduction by photo-zincography.
Preliminary Numerical Charts.				
Revised Chart of the Secondary Triangulation executed by the Burma Party, season 1877-80 ...	1	.....	4	For photo-zincography.
Ditto ditto 1876-77 and 1879-81	1	.....	4	
Secondary Coast Series from the town of Poorce to Bodagiri H. S. of the G. T. Survey, season 1882-83...	1	.....	2	
Aden Triangulation...	1	.....	½ or 1,760 ft.	
Compilations.				
Maps for Foreign Office	4	.....	On various scales.	For photo-zincography.
Chart of Arcs of Longitude, determined through the electro-telegraph, for the Annual Report ...	1	.....	144	For reduction by photo-zincography.
Sketch Map of the country within 10 miles around Allahabad	1	.....	1	For photo-zincography.
Chart of Spirit-levelling operations in Cuttack, Midnapore, Howrah, 24-Pergunnahs, &c., No. 5, Bengal Presidency	1	.....	8	For reduction by photo-zincography.
Map to illustrate Tribal Settlements on the North-West Frontier	1	.....	24	For photo-zincography.
Guide Map of Mussooree and Landour	.....	1	½ or 660 ft.	
Plan of Ehás to accompany A—K's report ...	1	.....	¼ or 1,320 ft.	
Maps of Astor and Gilgit with the surrounding country brought up to 1883	1	.....	4	
Map of Chakrata Cantonment for the *North-Western Provinces Gazetteer*	1	.....	½	
Skeleton Map of the district of Dehra Dún ...	1	.....	8	
Revised Sketch Maps to illustrate A—K's explorations in Great Tibet and Mongolia, 1879-82 ...	3	.....	8	For reduction by photo-zincography.
Spirit-levelled Height Charts, Nos. 6 (2nd edition), 67, 81, 83, 88 and 12 (3rd edition)	3	3	½ or 2,640 ft.	For photo-zincography.
Maps showing changes in the Sunda Straits caused by the eruption of Krakatao, for the Annual Report ...	1	.....	About 8	
Index to the revised Sketch Maps of A—K's explorations in Great Tibet and Mongolia, 1879-82, showing also the Sketch of Jángthang, &c.	1	.....	64	

MISCELLANEOUS.

Examined, reported on, and corrected for the press the following original sheets: those which appeared in last year's annual report received additional corrections.

Sheets Nos. 1, 2, 6, 7, 8, 9 and 23 of Cutch Survey.

Sheets 15 and 40; also sheet 15, sections 1, 2 and 3; sheet 35, sections 2 and 4; sheet 49, sections 13 and 14; sheet 50, sections 7, 9 and 11, with supplemental sections 1 and 3 of Guzerát Survey. Six sections of Surat City and Atlas reduction No. 76.

Sheets 6, 7, 10, 10*a*, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 33, 35, 43 and 45, all 2nd edition, of Kattywar Survey.

Sheets 13A, 14, 15 and 16 of Nepal Boundary Survey.

For reduction and reproduction by photo-zincography.

Plotted line of levels for the chart of the Aden Triangulation.

Inserted predicted tidal curves on 10 sets of photo-zincographed copies of the map to illustrate the effects of the waves caused by the eruption of Krakatao.

Extracted and tabulated latitudes and longitudes of numerous places in the districts of Jaunpur and Fatehpur for Mr. Fisher's Gazetteer of the North-Western Provinces.

Projected graticule and some points of the secondary triangulation of the Burma Party for the projection of additional intersected points observed by Moung Shoay Gyoke.

Prepared a concise statement of all the explorers' services.

Prepared the map showing the disputed boundaries in Bundelkhand for Major Wilson.

Inserted Mr. Floyer's routes in Persia on office copy of Major St. John's map of Persia.

Examined 163 proofs of maps and charts and 421 pages of Janum Sákhi of Guru Nanák.

Coloured 15,940 maps.

Prepared descriptions of bench-marks for level sheet No. 12 (3rd edition) and for level sheet No. 81 ... ... } For the press.

Prepared notes of A—K's explorations for Mr. Hennessey's summary and discussion.

Prepared graticules and plotted points—Great Trigonometrical Survey in Kishanganga valley and neighbourhood, for Ahmad Ali, Sub-Surveyor.

Prepared memorandum showing differences between Dr. Regel and other Russian surveys and the Indian explorers in the Upper Oxus Valley.

Drew 63 diagrams of bench-marks for level sheet No. 81 ... ... } For reduction by photo-zincography.

Prepared copy of a map (with a tracing) of Afghan-Turkistan for office use.

Prepared a tracing of level data in the district of Gorakhpur for Major Sandeman.

Prepared tracings of three sketch maps of Khatmandu valley by Captain Barrow.

Prepared a tracing of the Ranikhet cantonment.

Prepared tracings of Sarda canal.

Prepared tracings of the proposed extension of the Cawnpore Branch Canal.

Prepared copies of Colonel Forbes' levels in Oudh.

Prepared copies of level heights in sheets 36, 43, 47, 48 and 146 of the Oudh Revenue Survey for Major Cunningham.

Prepared a rough map of the Khatmandu valley for Captain Barrow.

Drew a chart of the intersected points observed by Ahmad Ali, Sub-Surveyor.

Drew and printed a diagram to illustrate the introduction to Synoptical Volume of S Maláncha and S Párasnáth Series.

Prepared a tracing of the route from Khiva to Dasht Kala.

Prepared a tracing of the Aden Triangulation Chart, 1876-77, for the Executive Engineer, Aden.

Prepared tracings of the charts of the tidal curves to illustrate the effect of the wave caused by the volcanic eruption of Krakatao.

Prepared a tracing of the boundary between Garhwál and Ramigarh, and of the boundary of Kotgarh for the Commissioner of Simla.

Marked the boundaries of districts on preliminary charts of the Eastern Sind and Sehwan Minor Series.

Enlarged sheet No. 46 of the Bundelkhand Topographical Survey for Major Wilson.

Examined and corrected the map of routes in the Western Himalayas, the Punjab, &c ... ... } For the engravers, Surveyor-General's Office, Calcutta.

Prepared drawings of the pillars at the east and west ends of the Mergui base-line.

Miscellaneous.—Current duties, including preparing for the press several maps of the Topographical Surveys and of the Forest Survey, transliterating Russian names, reducing maps by pantagraph, and affording assistance to officers and to the Photo-zincographic Office, &c.

CORRESPONDENCE AND STORES.

The year's correspondence is represented by about 2,800 letters and memoranda (inclusive of those already mentioned in connection with the protection of stations). Of these, some 1,780 are specially debitable to the office of the Deputy Surveyor-General.

Of instruments, &c., received and despatched there were—

Instruments despatched	...	...	...	...	909
„ received	...	...	...	...	211
Stores, articles despatched	...	...	...	...	204
„ „ received	...	...	...	...	135
Making up a total of packages and parcels received			...	...	235
„ „ „ „ „ despatched			...	...	103

SOLAR PHOTOGRAPHY.

Mr. L. H. Clarke, Surveyor 2nd grade, has continued to work as Solar-Photographer, assisted by Mr. C. F. Guthrie. The working facts for the year are given in the following table:—

1883-84.	Number of Days.				Number of Negatives.						Number of Working Days when Solar Phenomena were—	
	When negatives were taken.	Failures.			Solar Phenomena.				Rains.	Total.	Visible.	Absent.
		From bad weather.	From various causes.	Total.	Spots and Faculæ.	Spots only.	Faculæ only.	None.				
October	31	.....	.....	.....	89	.....	.....	.....	.....	.....	31	.....
November	26	4	.....	4	75	.....	.....	.....	.....	.....	26	.....
December	28	3	.....	3	74	.....	.....	.....	.....	.....	28	.....
January	29	2	.....	2	73	.....	.....	.....	.....	.....	29	.....
February	24	5	.....	5	69	.....	.....	.....	.....	.....	24	.....
March	24	4	3	7	73	.....	.....	.....	.....	.....	24	.....
April	26	4	.....	4	67	.....	.....	.....	.....	.....	26	.....
May	28	3	.....	3	71	.....	.....	.....	.....	.....	28	.....
June	17	13	.....	13	57	.....	.....	.....	.....	.....	17	.....
July	14	17	.....	17	30	.....	.....	.....	.....	.....	14	.....
August	18	13	.....	13	37	.....	.....	.....	.....	.....	18	.....
September	20	10	.....	10	50	.....	.....	.....	.....	.....	20	.....
Total ...	285	78	3	81	744	.....	.....	.....	.....	.....	285	.....

This table shows that during the year photographs of the sun were obtained on 285 days, and that of the 744 negatives taken all exhibit solar phenomena. From these negatives 475 silver prints were made.

Photographs of the sun are always taken at Dehra on every day of the year that the sun is visible, but during the year under report three days' record was lost owing to the sickness of the assistant photographer while the photographer was absent from the station on leave. The number of days, viz. 78, on which the sun was invisible has been unusually great during the year, the rainy season having been exceptionally wet.

The usual table of percentages regarding the daily visibility of the sun and the presence of features (*i.e.*, spots and faculæ) is subjoined:—

Year.	In 100 days the sun was invisible on—	In 100 working days features were present on—
1877-78	9 days (obtained from 273 days)	30 days (obtained from 248 working days)
1878-79	11 ,, ,, 89 ,,	28 ,, ,, 79 ,,
1879-80	14 ,, ,, 289 ,,	82 ,, ,, 232 ,,
1880-81	15 ,, ,, 365 ,,	96 ,, ,, 307 ,,
1881-82	10 ,, ,, 365 ,,	100 ,, ,, 328 ,,
1882-83	13 ,, ,, 365 ,,	100 ,, ,, 318 ,,
1883-84	21 ,, ,, 366 ,,	100 ,, ,, 285 ,,

Contrasting the percentages of days of invisibility above given with those for Greenwich as furnished by the Astronomer Royal's Reports, we have—

Year.	At Dehra, year ending 30th September.	At Greenwich, year ending 20th May.
1880-81 ...	15	60
1881-82 ...	10	45
1882-83 ...	13	45
1883-84 ...	21	.....

During the cold season some samples of specially prepared gelatine dry plates were obtained from England through the instrumentality of the Astronomer Royal, and were found to give excellent results; but when the weather became warm they could not be used, because then the emulsion with which they were prepared melted away in development. Ice is not procurable at Dehra, or this difficulty might have been surmounted. The advantages would be great if such dry plates could be generally used, and perhaps the chemist—Mr. L. Atkinson of 121, Greenwich Road, who prepares the dry plates employed at Greenwich—could in some way modify the emulsion so that it should better withstand heat.

The despatch to England of the negatives and of the silver prints has been made weekly as usual.

I regret to say I have no satisfactory report to give of the large photo-heliograph for taking 12-inch pictures of the sun. The new observatory was completed early in October 1883, and the instrument was at once adjusted in position and negatives taken with it, but for some unexplained cause no good negatives were obtained. Finding that the eye was no certain guide to obtaining actinic focus, attempts were made to get it by a series of experiments. These were to a certain extent only successful, for it was found that of two negatives taken apparently under exactly the same conditions, one might be fairly good, and the other altogether out of focus. The picture as viewed on the focussing glass seemed always in a state of unrest; sometimes for a few seconds it would look sharp and then immediately become blurred. Much time and thought were occupied in experiments to ascertain how to work the instrument satisfactorily, and these were continued till 1st February 1884, when Mr. Clarke went on leave and his assistant's time was occupied with the small photo-heliograph. When Mr. Clarke returned in April, the weather had become hazy and unsuited for systematic experiments, and very little could be done until the rainy season was over. Recently, by the Surveyor-General's order, a Committee was assembled to report on the instrument, which it did unfavourably.

In accordance with instructions from the Surveyor-General, certain maps and solar photographs were sent from the Trigonometrical Branch Office, Dehra Dún, to the Calcutta International Exhibition held during the winter of 1883-84. A silver medal was awarded to this office for the excellence of the sun pictures exhibited.

Monthly Meteorological Results taken from the Register kept at the Trigonometrical Branch Office, Survey of India, Dehra Dún.

YEAR AND MONTH.	BAROMETER REDUCED TO 32° FAH.						HYGROMETER.				THERMOMETER.								RAIN.		WIND.	CLOUD.	
	AT 9-30 A.M.			AT 3-30 P.M.			AT 9-30 A.M.		AT 3-30 P.M.		DRY BULB.					WET BULB.							
	Highest.	Lowest.	Monthly mean.	Highest.	Lowest.	Monthly mean.	Monthly mean temperature of dew point.	Monthly mean humidity.	Monthly mean temperature of dew point.	Monthly mean humidity.	Maximum in sun's rays.	Minimum on grass.	Maximum in air.	Minimum in air.	Monthly mean in air.	Maximum in wet.	Minimum in wet.	Monthly mean wet.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 9-30 A.M.	At 3-30 P.M.
1883.																							
October	27·860	27·619	27·747	27·761	27·526	27·656	55·9	·587	55·4	·453	105·2	44·3	86·0	53·6	70·6	72·5	48·1	59·5	.....	.....	N.	.....	1
November	·852	·695	·762	·757	·600	·678	50·5	·709	50·7	·526	91·2	36·7	77·0	44·0	60·6	61·5	41·8	53·0	4	1·52	Calm.	2	2
December...	·941	·764	·997	·839	·677	·781	42·3	·663	44·2	·490	81·3	31·5	69·0	38·3	54·4	55·5	37·2	46·7	1	0·09	N.	2	2
1884.																							
January	·924	·697	·859	·834	·653	·756	45·8	·715	47·6	·509	84·5	32·8	71·6	39·6	55·6	61·0	37·5	49·6	.....	.....	N.E.	3	4
February	·866	·599	·755	·790	·526	·657	44·9	·655	45·3	·456	91·2	30·8	79·2	37·2	57·5	61·4	34·8	48·7	2	·53	W.	3	5
March	·944	·551	·674	·850	·456	·588	50·5	·531	48·2	·347	107·6	41·0	90·0	46·6	68·1	73·0	45·0	55·4	4	·64	,,	3	3
April	·732	·510	·604	·619	·430	·509	46·2	·332	43·1	·221	113·2	46·8	94·9	57·1	77·0	73·1	45·6	59·1	.....	.....	.....	3	5
May	·620	·373	·485	·528	·279	·393	52·5	·318	49·9	·254	120·5	56·5	106·3	61·9	84·8	79·5	53·3	64·0	3	·21	N.W.	1	3
June	·501	·386	·418	·461	·232	·347	65·9	·546	65·5	·503	120·6	60·5	104·3	70·0	84·1	83·9	60·4	71·2	13	5·27	,,	3	5
July	·540	·314	·412	·462	·257	·333	73·1	·837	74·0	·737	111·2	67·6	92·3	70·3	80·1	79·5	67·6	74·5	25	24·63	Calm.	3	7
August	·584	·339	·451	·495	·244	·373	72·5	·860	73·6	·825	113·8	63·6	88·7	68·5	77·5	79·7	65·0	73·3	25	26·60	,,	7	8
September	·631	·434	·562	·560	·362	·472	70·7	·840	71·8	·780	118·3	62·4	85·4	66·8	76·4	78·0	64·9	71·5	20	15·97	N.	5	7

NOTE.—The height of the barometer cistern above mean sea-level at Kurrscheo is 2,232·41 feet.

Mean velocity, in miles, of the winds which blew at Dehra Dún during the twelve months of 1883-84 *for each hour of the day.*

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
0 to 1	2·48	1·90	2·03	2·58	2·20	2·32	1·77	1·50	0·89	1·26	0·77	0·56
1 „ 2	2·00	1·63	1·74	2·81	2·12	2·39	1·58	1·82	1·26	1·19	0·83	0·93
2 „ 3	1·68	1·47	1·81	2·90	1·88	2·19	1·31	1·45	1·33	0·87	0·97	1·21
3 „ 4	1·48	1·10	1·42	2·48	1·68	1·65	1·38	1·09	0·89	0·81	1·00	1·03
4 „ 5	1·29	0·97	1·32	1·84	1·76	1·46	1·38	1·27	1·15	0·87	0·60	1·00
5 „ 6	0·97	0·80	1·19	1·71	1·60	2·00	1·50	1·59	1·00	0·87	0·60	1·17
6 „ 7	0·74	0·90	1·35	1·90	1·24	1·48	1·27	1·45	0·67	1·06	0·70	1·21
7 „ 8	0·43	0·80	1·19	1·42	1·04	0·84	1·46	1·06	1·33	1·52	0·33	1·21
8 „ 9	0·52	0·67	0·87	0·77	1·12	1·42	1·58	1·50	1·78	2·06	1·24	1·58
9 „ 10	0·72	0·93	1·13	1·23	1·72	1·77	2·85	2·81	2·81	1·94	2·03	1·29
10 „ 11	1·23	1·23	1·32	1·48	2·42	2·13	3·62	4·00	3·41	2·52	2·17	1·90
11 „ 12	1·74	1·70	1·71	2·42	2·58	2·81	4·42	4·43	2·79	2·13	2·07	1·76
12 „ 13	2·49	1·90	2·32	2·84	3·56	3·45	4·38	5·05	3·26	2·39	2·07	2·10
13 „ 14	2·94	2·13	2·30	2·94	3·76	3·71	5·17	5·03	3·33	2·32	2·70	2·17
14 „ 15	2·45	1·72	2·45	2·94	3·64	3·72	4·80	5·95	3·78	2·45	2·77	2·18
15 „ 16	1·55	1·52	1·71	2·52	3·72	3·65	5·23	6·18	2·89	1·69	2·23	2·27
16 „ 17	0·29	0·70	0·90	1·97	3·48	3·81	5·64	6·21	2·70	1·68	2·20	2·00
17 „ 18	0·58	0·27	0·42	0·74	1·48	2·42	5·32	6·00	2·15	1·42	1·40	0·97
18 „ 19	2·10	1·00	1·06	0·77	0·44	0·61	2·84	4·29	1·59	0·97	0·90	0·79
19 „ 20	2·48	1·73	2·05	1·65	0·64	1·65	1·84	2·38	0·89	1·35	0·60	0·72
20 „ 21	2·71	2·17	2·23	3·19	1·20	1·65	1·64	2·21	0·63	0·84	0·87	0·46
21 „ 22	3·19	2·23	2·38	2·52	1·92	2·52	2·24	2·17	1·41	1·03	0·70	1·14
22 „ 23	2·97	2·30	2·71	2·45	1·96	2·45	1·96	1·54	1·26	0·90	0·80	1·31
23 „ 24	2·99	2·23	2·18	2·52	2·20	1·94	1·96	1·68	1·00	1·06	0·70	1·38
Sums ...	41·90	34·10	40·24	49·39	49·56	54·09	67·59	72·64	43·99	35·19	31·65	33·29
Average ...	1·75	1·42	1·68	2·07	2·07	2·25	2·82	3·03	1·83	1·47	1·32	1·39

Principles agreed upon between the Settlement and the Survey Departments for carrying on the work in Deoria Tahsil, Gorakhpur District.

THE division of labour between the Survey and the Settlement is based on the principle that the Survey undertakes to furnish an accurate record of all undisputed entries. The Survey has its own checks: *munsarims* check 20 per cent. of the entries in the *khasra*; the European staff check 5 per cent. It is waste of time and money for the Settlement to put on a staff of *munsarims* to check work which has been already sufficiently checked. The Settlement *munsarims* are men of the same class and attainments as the Survey *munsarims*.

2. But the Survey cannot settle, and must not stop to attempt to settle, disputes. Its duty, shortly, is to record the names of persons found to be in undisputed possession, and to prepare a complete list of all disputes. The Record cannot be accurately made out if this dispute list is not complete.

3. During the survey, therefore, the only duty of the Settlement is to see that the *khewat* is ready when entries begin, and that it corresponds with facts.

4. When the *Khanapuri* of a village is finished, and has undergone the checks to which it is submitted by the Survey, the Survey *munsarims* will send in to the camp office:—

1. The Urdu *khasra*.
2. The Hindi *khasra*.
3. The *jamabandi* slips.
4. The dispute list.

5. The camp officer will then examine the dispute list. If there are no disputes, the papers may be at once arranged and statistics abstracted. If there are disputes, the camp officers will see whether they are of such a kind as can be adjusted by a *munsarim* on reference to the *patwari's* papers. Such are generally disputes as to occupancy. Disputes as to ownership are of a different class, and can only be settled by an authoritative order of the Deputy Collector.

6. If there are no disputes, or if the disputes are of a kind which can only be settled by the Deputy Collector, the papers will be at once arranged and abstracted. If the camp officer considers that there are disputes which can be settled by a *munsarim*, and that the non-settlement of these disputes will leave the papers incomplete, and make the statistics inaccurate, he will prepare a tracing of the map and forward it with the Urdu *khasra* and dispute list to the Deputy Collector's office. The Deputy Collector will arrange to forward the papers to a *munsarim*. That officer will go to the village, summon the parties, inspect the *patwari's* records, if necessary, and come to a decision on the disputes. He will make the necessary attestation in the *khasra* so as to fill up all blanks, and in the dispute list, and the Survey Department will be responsible that the Hindi *khasras* and *jamabandi* slips agree with the amended *khasra*. The *munsarims* will return the papers direct to the camp office. Even if the people do not agree, he is bound to come to a decision in the case of every dispute, except cases of ownership, into which he will not enter. He will inform people who are dissatisfied that they may bring a claim before the Deputy Collector. The *munsarim* will be careful to note his decision, and the grounds for it, in the dispute list.

7. Before the abstraction of statistics commences it is necessary that the conventional soils should be checked by a special *munsarim*, called the soil-*munsarim*. As soon as possible after the *misl* is received, a trace, called the assessment trace to distinguish it from the record trace, will be made and coloured so as to show *goind*, *manjhar*, and *palo* according to the *khasra*. The soil-*munsarim* will take this to the village and correct the boundaries of soil tracts so as to correspond with what the people really consider to be *goind*, *manjhar*, and *palo*. The trace will then be returned to office, and the soils will be abstracted according to the new demarcation, and the *khasra* entries corrected accordingly. Both demarcations, however, will be shown on the map. This trace will be the one used by the Settlement Officer next year at assessment, and it must be signed by the soil-*munsarim*.

8. It is understood that the soil entries, both natural and artificial, will in the first instance be made on the responsibility of the *patwari*. The basis of the classification is what the "people" call *goind*, *manjhar*, *palo*, *doras*, *bhat*, &c., and not what an *amin* thinks is any particular soil. The Survey, however, will, on partal, see that the entries are fairly made. The demarcation of the soil-*munsarim* will not be considered final till the Settlement Officer has inspected the villages next cold weather.

9. The soil-*munsarims* will be under the orders of the camp officers. The Settlement *munsarims* will be under the orders of the Deputy Collector. The duty of the latter is to see that the *khewat* is in the hands of the *patwari*, and is properly prepared; to move about their circles adjusting disputed entries; to make local enquiries when required by the settlement, and to revise dispute lists sent from the camp. The Deputy Collector will expect that dispute lists and *khasras* sent from camp will be returned within four days.

Each soil-*munsarim* will have no *muharir*, but three *chuprasis*.

Each *khewat-munsarim* will have a *muharir* and four *chuprasis* to summon parties to disputes. It is part of their duty to see that disputed boundaries are surveyed as decided by the Deputy Collector, and having done so, to return the trace to the Survey Office, marking on it the fact.

10. Settlement work proper begins when the completed *misl* is sent to the Deputy Collector. It is twofold—*firstly*, attestation of the record and settlement of disputes; *secondly* assessment. For the first, the Survey furnishes the record of undisputed entries and a dispute list. The Deputy Collector will first of all cause a rough *jamabandi* to be made from the slips. This rough *jamabandi*, the *khewat*, the *khasra*, and the note on village custom, will be attested at one and the same time, first by a *munsarim* and then by a Deputy Collector, who will have before him all the papers and the original dispute list. The *patwaris* must be present at both attestations. If the whole circle of a *patwari* has not been surveyed, and he is still engaged in *khanapuri*, the Deputy Collector must arrange so that the *khanapuri* be not delayed. No hard and fast rule can be drawn up. The Deputy Collector, knowing that the work of preparing the record for the Pargana is one, must arrange that the *khanapuri* is not hindered.

11. The following points are noted:—

(*a*) The camp officers will issue stamped and numbered sheets of the *khasra* in Urdu to the *amin*, so that no sheet can be removed and another substituted. The *amin* is bound to account for the number of sheets which he receives.

(*b*) Stamped dispute lists, with the name of the village written by the camp officer, will also be issued, so that the lists be not changed.

(*c*) The areas in columns 9, 11, 12, 14 of the *khasra* will be in acres, but the *milan khasra* will show bighas.

J. D. LaTouche,
Settlement Officer.

The 18th January 1884.

J. E. SANDEMAN, *Major*,
Deputy Superintendent of Survey, No. 5 Party.

Note on the Procedure in Gorakhpur for the preparation of Record-of-Rights, dated 8th February 1884, *drawn up by* Major J. E. Sandeman, *Deputy Superintendent, Survey of India, for the information of the Senior Member, Board of Revenue, North-Western Provinces.*

Our endeavour has been to improve on the Benares system, which was the one approved of at the meeting held at Benares on the 11th January 1883. In Benares, Settlement *munsarims* attest the entries as the survey proceeds. The attestations are thus made without areas; the *khanapuri* is delayed to a certain extent, and a good deal of friction is inevitable between the Survey and Settlement staff. The procedure in Gorakhpur is as follows:—

(1). The Settlement *munsarims* get ready the *khewat* and hand them over to the *patwaris*.

(2). The Survey establishment make all the undisputed entries and a list of all disputes: 20 per cent. of the entries are checked by Survey *munsarims* who have had settlement experience, and whose knowledge of *khanapuri*, as laid down in the hand-book of instructions issued for their guidance, is tested and known to be great; an additional 5 per cent. of the entries are tested by the European staff as they check the survey. The executive officer holds himself responsible for the correctness of the entries; that they are in accordance with the *khewat* in column 3 of the *khasra*, and in column 4 with cultivating possession; and that all disputes as to the entries in both columns are inserted in the dispute list. At the same time, the natural soils and their conventional classes are entered on the spot on enquiry from the *patwari*, the *zamindars*, and the cultivators, the proviso being that if the statements are manifestly wrong in any case, they will be referred to the *munsarim*, who will decide as to the correct entry. Not only are 25 per cent. of the entries checked, but another safeguard as to accuracy is that three documents are prepared on the spot at one and the same time.* While the *amin* writes the Urdu *khasra*, the *patwari* prepares a duplicate in Nagri, and a *parcha*, for each cultivator on the spot, which is handed to him as his number is entered. All three documents are read out aloud, and no entry is made unless the *patwari*, the proprietor, and the cultivator are all present. The only drawback to this thoroughness is that if the people are disinclined to help, great delay occurs from the absence of some one or other who should be present.

* This is also the procedure in Benares.

When a village is completed and the papers go into the camp survey-office, the areas are at once extracted and entered into the duplicate *khasra* and into the *parcha jamabandis*; the *safaiwar* and *milan khasra* and a *terij* of the *jamabandis* are then got ready. Here for the present the survey work ends, and the settlement work which was begun in the preparation of the *khewats* is continued.

(3). A race of the map, called the settlement trace, having been made over to the special soil-*munsarim*, he goes out and checks the soil classes as entered by the survey establishment. The natural soils are accepted as correct, the 25 per cent check which has already taken place being considered sufficient. The Urdu *khasra*, with a trace called the record trace, and the dispute list, having been sent out to a settlement *munsarim*, he fills up the disputed entries in column 4 by reference to the *patwari's* papers; and if the cultivators are not satisfied, they have an appeal at attestation: all disputes in column 3 are left blank to be filled up at attestation.

(4). Here the settlement work ends for the present, and the survey office again takes in hand the papers, correcting the *khasras* from the revised settlement trace, and filling up the disputed entries in the Nagri *khasra* form, in the corrected Urdu *khasra*, and in the dispute list, and it then proceeds to extract the statistics for the Settlement Officer, classifying the areas, under-tenures, crops, soils, and castes of cultivators.

This done, the papers are handed over complete in every respect to the Settlement Department, the Survey Department holding itself responsible that the entries in the duplicate *khasra* and in the *parchas* agree; if they do not, the papers are returned for correction, all other trifling mistakes being corrected in the settlement office.

(5). The Survey Department has now all but done with the records, and the settlement work of attestation begins.

(6). After the Settlement Officer has himself finally passed the soils, he once more returns the settlement trace to the survey office.

(7). With this trace the original maps are compared, and the soils are marked out on them by convenient symbols, with the aid of which the maps can be coloured for soils after publication. Thus for the first time the published maps will also be soil maps.

The merits of the system are that the work is done thoroughly in every stage, and that instead of the papers leaving the survey office in an incomplete state, as they did under the Benares system, they are prepared in such a way that on receipt of them the settlement officer can at once proceed to calculate his rates. Also that in their preparation they derive the benefit of the superintendence of the whole European staff of the survey party and of its carefully trained office establishment, which is habituated to dealing with figures in a systematic manner.

The Settlement staff and the Survey staff have distinct duties which cannot clash, and therefore there can be no friction. In the seven stages of the work described above, in which the two departments are associated—

No. 1	stage is performed	by the Settlement Department.	
„ 2	ditto	by the Survey	ditto.
„ 3	ditto	by the Settlement	ditto.
„ 4	ditto	by the Survey	ditto.
„ 5	ditto	by the Settlement	ditto.
„ 6	ditto	by the ditto	ditto.
„ 7	ditto	by the Survey	ditto.

The economy of this division of labour will be apparent in a couple of seasons; the entire work of the Survey Department, including the extraction of statistics, will cost just what the mere survey used formerly to cost, or about 4 annas an acre. The Settlement establishment is a small one, viz.—

2 Deputy Collectors with a staff for fairing the papers.
2 Soil-*munsarims*.
6 *Munsarims* for filling up disputed entries, and a small staff for attestation.

The cost of the above will fall probably within an anna an acre.

This season there are disadvantages which will not occur again: the chief of these is that the establishment is new to the work. The first four weeks were occupied in training it, and during the next four the progress was naturally slow. Nearly half the men are new, and to the rest the training in Mirzapur has been of little advantage, for there the tenure was comparatively simple; only one document, the Urdu *khasra*, was prepared by the *amin* on the spot, the Nagri *khasra* and the *parchas* being made up from it during the recess. Our difficulty has been to break the men of the habits acquired, and to make them wait for the entry to be made in the *parcha* at the same time as it is in the *khasra*.

Copy of letter No. 72—I 1, *dated* 11*th February* 1884, *from the Settlement Officer, Gorakhpur, to the Commissioner, Benares Division.*

WHEN I had the honour of meeting you and the Senior Member of the Board of Revenue at Basti on the 7th February, I was desired to submit three reports:—the first, on the modifications of the Benares system which have been adopted by Major Sandeman and myself in preparing the Record; the second, on the method by which I propose to proceed in revising the land revenue assessment; the third, on the prospects of the work in general and the arrangements which will be necessary to ensure the announcement of the revised revenue of the district not later than the year 1889. The present letter is the first of the series.

2. We make out the same papers as were compiled in the Benares survey—An attested *khewat* is prepared in advance by the Settlement; the Survey *amin* writes the Urdu *khasra*; the *patwari* or his *gomashta* writes the Nagri *khasra* and the *jamabandi* slips; the list of disputes is made out in Urdu by the *amin*. But the question had to be faced as to which department was responsible for the accuracy of the entries. If the Survey was willing to undertake the responsibility, and could ensure accuracy, it was evidently waste of power for the Settlement to put on a staff of *munsarims* to check work which was already sufficiently checked by the Survey. If the Settlement was responsible and employed its own agents,

the large staff of the Survey would confine its efforts to securing merely accuracy of measurement. Our object was to make all men employed in the field feel that the work of survey and settlement was one, and to avoid friction between the departments, and we found that this could only be done by a fair division of labour. We soon hit upon the broad generalization that the Survey should undertake to furnish an accurate record of all undisputed entries, and a complete list of all disputes. This principle is the basis of the whole work.

3. It is evidently waste of time to test twice over on the field matters about which there are no disputes. The staff of Survey *munsarims* was considerably increased by Major Sandeman. They check 20 per cent. of the entries in the *khasra*. The European staff of the Survey check 5 per cent. The Survey *munsarims* are men of precisely the same class and attainments as the men who would have been employed by the Settlement. The Settlement therefore should accept all undisputed entries in the *khasra* as *primâ facie* correct.

4. It is different when a dispute arises. The Survey cannot settle and must not stop to attempt to settle disputes. If a dispute arises, the *amin* must leave the entry blank, note the claims in the special dispute list provided for that purpose, and pass on to the next field.

5. When the papers of a village are finished and have undergone the checks to which they are submitted by the Survey, the *munsarim* sends into his camp office the Urdu *khasra*, the Hindi *khasra*, the *jamabandi* slips, and the dispute list.

The camp officer then examines the dispute list. If there are no disputes, or if the disputes are about ownership, which can only be settled by an authoritative order of the Deputy Collector, the papers are at once arranged, areas filled in, and the statistics required for assessment are abstracted. If, however, there are disputes as to tenancy, the camp officer prepares a tracing of the map, and sends it with the Urdu *khasra* to the Deputy Collector's office. Here it is at once made over to a Settlement *munsarim*, and this is the first occasion, excepting the *khewat*, on which the Settlement Department has official cognizance of the record which is being framed. The Settlement *munsarim* goes to the village, summons the parties, inspects the *patwari's* records, and even if the people do not agree, he is bound to come to a decision in every dispute, except in cases of ownership, into which he does not enquire. Any person dissatisfied is directed to bring a claim before the Deputy Collector. The *munsarim* fills up the blanks in the *khasra* and notes his decision and the grounds of it in the dispute list. He then returns the papers to the survey office. The survey office is responsible that the Hindi *khasra* and the *jamabandi* slips agree with the Urdu *khasra* as returned by the Settlement *munsarim*, and with each other.

6. While the *munsarim* is settling disputes, the survey office has inked up the map, and filled in the areas of the fields in the Hindi *khasra* and in the slips. A separate tracing of the map for assessment purposes has also been prepared, but of this more hereafter. On receipt of the *khasra* with all blanks filled in, statistics are abstracted. The papers are then complete, and are sent to the Deputy Collector, who gives a receipt. We have agreed that the *misl* shall not be returned for correction to the Survey on any other grounds, except that the tale of slips is not full, or that the three papers do not correspond. This much the Survey guarantees.

7. Settlement work proper begins as soon as the papers are received by the Deputy Collector. First of all a rough *jamabandi* is made from the slips. I do not consider that any proper attestation can be made on the slips alone. Many tenants hold land in more than one *patti*, and under different tenures in each, and it is necessary to bring all the totals together before attestation. A *muharir* takes this rough *jamabandi*, the *khewat*, and the *khasra* to the village and reads out the entries. The Deputy Collector follows and attests the record, having all the papers before him, as well as the original dispute list and the note on village custom. After the Deputy's attestation the papers are ready for fairing. The original slips after being corrected and signed are given to the tenants.

8. The attestation work is hardly yet in full swing, for we have been hampered by the fact that *patwaris'* circles are large, and that even after the settlement receives the complete record of one village, the *patwari* will be occupied in writing up his *khasra* in another. Still the work will soon be well advanced. Both Deputies will be employed in attestation from 1st March. Major Sandeman hopes to hand me over complete *misls* for all villages in Deoria Tahsil by the 1st May. The Deputies hope to attest all these between the present date and July, and I trust that we shall be able to carry out the programme. We then shall be able to give the *patwari* a fair copy of the attested *jamabandi* before October. He has his own Hindi *khasra* and the tracing of the map, and he may begin his annual *khasra* according to new map from October 1884. The entire Survey and Settlement staff, excepting the Settlement Officer, will be out of the tahsil within the year. The only portion of the record which remains to be completed are the columns of the *khewat* showing the distribution of the revenue. These can only be filled in after the new assessments have been declared. They will, it is hoped, be ready by April 1885.

9. At the meeting at Benares in January 1883 it was decided that the *wajib-ul-arz* as an attested record should be given up, but that a note should be made to the *khewat* of the matters which it is compulsory to record. These are enumerated in section 65, Act XIX of 1873, and are only two: the manner of distribution of common profits among the proprietory body, and the manner in which *lumberdars* and co-sharers are to collect rent from the tenants. Most of the matters referred to in section 51 of the Board's circular will be provided for in the *khewat* and in the *jamabandi*, but for general customs it will be perhaps advisable to draw up a Pargana Code. If the custom of any village differs from the ascertained custom of the Pargana, it could be proved when occasion arose.

10. The points at which our procedure seems most to lie open to exception are two,—our method of soil classification, and the fact that the village statistics are compiled by the survey from the unattested records. There was presented to us a choice of evils—either to postpone the compilation of statistics till the villages had been attested and the soils inspected by the Settlement Officer, or to allow the Survey to compile them at the same time as the areas of the fields are taken out. The Survey can do this work much better than the Settlement Department, and much cheaper. They have a staff of eight European assistants to check the work, and their men are much more expert at figures than any men whom I could employ. It is most important that I should have the village statistics before me at time of inspection. Otherwise inspection degenerates into a mere checking of soils. With the figures before me, many questions arise which can be solved at once by a question to the *patwari* or the *zamindars*. Unless, therefore, I am to postpone village assessment till 1886, the statistics must be taken out this year and be entered in the pargana note book by the 1st November 1884.

11. Soils are divided into five natural classes—*Doras* or *domat*, *matyar*, *balua* or *bhur*, *bhát*, and *kachhár*; and into three conventional classes—*goind* or homestead, *miyana* or middle land, and *palo* or outlying. These classes are all well known to, and recognized by, the people. *Doras* (loam) is the prevailing soil; *matyar* (clay) practically corresponds with rice land. Outlying *balua* (sand) certainly pays a lower rate than other outlying; *bhat* is a soil peculiarly retentive of moisture on which sugarcane grows without irrigation: it is common in the north and east of Deoria or in Sidhua Jubna. Whole tappas are composed of *bhát*, and the line between it and the *bangar* (up-lands) or the *doras*, *matyar*, and *balua* tracts is very distinct. *Kachhár* is the alluvial soil along rivers. Rents are not based on these distinctions as a rule; but rice often pays exceptional rates. The eastern or southern *har* of a village will often be found paying a different rate from the western or northern, and the cause is seen to be in the difference of the natural soil. *Kachhár* land varies much in productiveness, but a *kachhár* village has generally a very high rent rate. The natural soils therefore should be shown in the statistics and on the tracing of the map which is prepared for assessment purposes, and which is quite distinct from the record trace.

12. We have decided that the classification of the natural soils shall be left to the Survey Department. Rent rates will not be worked out per natural soils, nor are rents consciously paid according to soils. The people have no great inducement to make a false statement as to the soil, and its classification practically falls into the category of undisputed entries which we have made the province of the survey. Natural soils, in short, are only one of the numerous facts which the settlement officer has before him in village assessment. They are comparable to statistics, as to the density of population, the caste of tenants, the depth of wells, the neighbourhood of markets, and other facts which explain and justify a village rate. I prefer not to deprive myself of the assistance which can be derived from them in framing a fair assessment on a village.

13. With conventional soils it is somewhat different. These are consciously recognized by the people as influencing rent. I intend to frame rates for *goind*, *miyana*, and *palo*, and I must get a correct area to which to apply my rates. It will be admitted that the correct area of *goind* is the area which the people themselves recognize as *goind*, and not what any expert may consider to be *goind*. I disclaim any desire to attempt a scientific demarcation of soils. My duty is to ascertain a fair rate for each soil, and to apply that rate to the area recognized by the residents of the village as coming under each class. There is really only one way of discovering these areas, and that is for the assessing officer to go and do it himself; but he may be helped in one of two ways. A special *munsarim* may be appointed who will take a tracing of the map to the village, and mark on it the boundaries of the *goind* and *manjhar*; or the Survey may at the time of measuring each field, record what the *zamindars* and *patwari* consider to be its class. The tendency of a *munsarim* working alone is to put in too much *goind* and *manjhar*. The *zamindars*, if left entirely to themselves, would not state their real opinions. The system on which we are at present working combines these two methods, and is as follows:—

14. As each field is measured, the *amin* enters the conventional class from the statement of the *patwari*. If he considers the *patwari* to be palpably wrong, he refers the matter to the survey *munsarim* at his next visit. As soon as the papers reach the survey office, a special trace is made for assessment purposes. On this are drawn lines showing the demarcation of *goind* and *manjhar*, and the tracing is then made over to a special *munsarim* attached to the survey camp. He takes the trace to the village and corrects the line where he considers it clearly wrong. The *khasra* entries are changed to correspond to his correction, and statistics are made out according to the amended demarcation. The tracing is signed by the *munsarim*, and is the map which the settlement officer will use in inspection next year. The assessing officer will therefore have before him the original demarcation and the opinion of the *munsarim*, and must make up his mind as to what is a fair demarcation. As soon as he has passed the map, the tracing will be returned to the survey, and the demarcation of the settlement will be printed on the published maps.

15. The question, however, of soil-classification is not so important as might be supposed. Throughout Salempur there are but few large village sites. The population is scattered over the country in minute hamlets. There is but little high garden cultivation, and, except in large villages, hardly any outlying. Where the *miyana* of one hamlet ends, that of another begins. It is very common to find only two rates of rent in a village—one for poppy land, and one for everything else. It is true, however, that a new tenant obtaining land would have to pay for it according to its proximity to the village site.

16. The statistics furnished to me by the Survey show the area classified as required for statement No. II, the soil classification of the *munsarim*, the amount of land held as *sir* in occupancy or at will, the caste of tenants and how much land is held by each caste, the number of wells and how many were built within the last 10 years, depth to water, the crops found on the ground, and in short all the statistics which go to make the "present" columns of the Pargana note-book. I have abstracted from the records in the Collector's office comparative statistics of previous settlements—rent-rolls for the last 12 years, transfers during the currency of the settlement, and census returns. The form of note-book adopted is substantially the same as that used by Mr. Cadell for the assessment of Banda, and all these statistics I shall have before me when I begin village assessment next November.

17. I do not think I have omitted any detail of importance which may serve to explain what is being done. The broad principle of division of work we shall not alter if we are allowed to work in this way, but I would not wish that anything I have said should bind me and Major Sandeman from making alterations which further experience may show to be advisable. The combined work of survey and settlement is still in an experimental stage. Every detail requires to be watched: difficulties must be expected, and it will be some little time before things go on perfectly and smoothly.

Copy of Board's No. 136—IX 19 *of 7th March* 1884 *to the Commissioner, Benares Division.*

I AM desired to acknowledge the receipt of your letter No. 1419—I 15, dated 21st ultimo, and enclosure, regarding the system on which it is proposed to prepare the Record-of-Rights in the Gorakhpur district.

2. In reply, I am to observe that the improvement by Mr. LaTouche and Major Sandeman on Major Barron's system, and the unison in which the Survey and Settlement Departments are working in Gorakhpur, are additional evidence of the success of the present combined system, the advantages of which are summed up in paragraph 9 of your letter.

3. The Senior Member considers that the division of labour in the classification of soils has been wisely made, it being left to the Survey Department to fill in natural soils, the decision of the conventional soils being left to the Settlement Officer.

4. The Senior Member found the most cordial good feeling existing between the heads of the two departments, the best guarantee for the work being well done.

5. With reference to your paragraph 8, I am to say that there is no desire whatever on the part of the Board to stereotype a system which, although successful so far, is still on its trial: while therefore the Board entirely approved the working of the system as far as it has gone, they will be quite ready to welcome the introduction of any further improvement which the experience of the settlement and survey officers may hereafter show to be desirable. Meantime the exertions of both officers merit the Board's cordial acknowledgment.

Copy of letter No. 55—*IC* 2, *dated the* 15*th November* 1884, *from the Settlement Officer of Gorakhpur to the Judge of Gorakhpur.*

I HAVE the honour to address you on the subject of regular suits affecting the boundary of villages in the jurisdiction of the Bansgaon and Deoria Munsifs. I understand that a number of suits have been filed to contest the demarcation made by the Settlement Department, and from the energy displayed in prosecuting and defending appeals in my court, I am led to believe that this class of suit will increase.

2. Many of the boundary disputes which have arisen at this settlement have from time to time been settled by decrees of the Civil Court, in many instances appealed up to High Court, yet one of my greatest difficulties has been to discover what it was that was actually decreed. The suitor claims so many bighas of land, and this has been often decreed on the faith of incorrect maps and a very imperfect survey. For instance, a suitor finds that in the settlement map the width of a plot on the border is 1½ chains, while in reality it is only 1. He sues for the extra land, which, as a matter of fact, does not exist, and many decrees have been given which were incapable of execution.

3. The maps which are now prepared under the Survey Department are mathematically accurate; boundary lines do not overlap, as was too often the case at last settlement, and each boundary line accurately fits into the neighbouring one. Maps have been completed for the Deoria tahsil. In Bansgaon the survey is now at work.

4. It seems to me very important that all decisions passed by the Civil Courts should be accurately laid down on the ground, and transferred to the new maps for permanent record. The maps of disputes which are now prepared by the Civil Court *amins* (I speak of some which I was permitted to see by the courtesy of the Munsif of Bansgaon) are no better than those made half a century ago.

5. I would suggest therefore for your consideration the advisability of the issue of some such rules as the following in cases of disputed boundaries:—

(1.) That in villages which have been surveyed by the Survey Department the Civil Court should call on the Deputy Superintendent of Survey to furnish a trace of the boundary as surveyed, showing as many fields on each side as may be required.

(2.) That the Civil Court, after decision, should mark on the map the line decreed, and forward a trace to the Settlement Office, that the records and the map may be corrected accordingly.

(3.) That in villages which have not been surveyed, an accurate survey of the boundary and the adjacent fields should be made for the Civil Court, and that this survey should be so made as to be capable of being transferred to the new map, and that on receipt of the trace showing the decided line it should be transferred to the new map.

6. As far as I am aware, the *amins* now employed in the Munsifs are incapable of making such a survey as that alluded to in the last clause. I would suggest therefore one of the two courses:—*First*, that the Deputy Superintendent be requested to make a survey of the disputed tract. This, as I have ascertained, Major Sandeman is willing to do, and in tahsils where the cadastral survey is in progress, the preparation of such a map will not entail much extra labour; or *secondly*, that the present Civil Court *amins* be examined by Major Sandeman, and if found incompetent to make as accurate a map as that of the survey, that they should be replaced by fit men to be nominated by the Deputy Superintendent of Survey.

7. If some such procedure as this be adopted, the Civil Courts of first instance will, I believe, find the work of deciding these disputes very greatly simplified; Appellate Courts will see at a glance what has been decreed; litigants will learn to base their claims on actual fields, and not on vague and inaccurate surveys; the Record-of-Rights will correspond with the Civil Court decrees, and all litigation for the future will be stopped since it will be at any time possible to lay down on the ground the line of decision. At present, it is impossible to do this, since the maps of decisions are inaccurate.

Copy of letter No. 49—*ID* 2, *dated Gorakhpur, the* 13*th November* 1884, *from the Settlement Officer, Gorakhpur, to the Deputy Superintendent of Survey in charge No.* 5 *Party, Gorakhpur.*

I HAVE the honour to place on official record the arrangements which we have agreed upon on the subject of soil demarcation.

2. The natural soils which we adopted in Deoria were five in number—*Doras*, *Matyar*, *Baluæ*, *Bhát*, and *Kachhár*. Our object was to select marked distinctions which affected rent. Experience has shown that the rent-rate of *Doras* and *Matyar* is generally identical in a village; a *Baluæ* tract generally pays a low rate; the rate on *kachhár* lands may be either higher or lower than the *Doras* of the village. *Bhát* is a peculiar soil much infected with *Usar*, and it is advisable that its area should be separately shown, and it is easily recognized. We might then have joined *Doras* and *Matyar* into one class, but the clay soil is nearly always that on which rice is grown: there is no name known to the people which would comprehend both classes, and you have told me that amalgamation of them will not perceptibly lighten the labour of extracting statistics; we have agreed therefore to retain the five classes.

3. The conventional soils are *Goind*, *Miyáná*, and *Palo*. The procedure of last season was that the Survey's demarcation of natural soils was accepted after the usual checks of that department; but for conventional soils a separate *munsarim* was appointed by the Settlement, who, with the map in his hand, checked and altered the demarcation made by the Survey with a view of ascertaining that it corresponded with the demarcation recognized in the village.

4. The distinctions of the natural soils are all such as are visible to the eye. *Kachhár*, or low-lying land along a river which is flooded every rains, and on which the river leaves a fertile or a sandy deposit, cannot be mistaken. *Bhát* is easily recognized. The only soils likely to be confounded are *Doras* and *Balua*. Light *Doras* cannot often be distinguished from *Balua*: the rent-rate is the only guide. Where land which is doubtful is found paying the same rate as *Doras*, it should be classed as *Doras*; if it is found to pay a lower rate, it should be classed as *Balua*. As I have said, these distinctions can all be recognized by the eye; they are indisputable facts which the Survey can record with as great accuracy as the statistics of a well or of a grove.

5. The demarcation of conventional soils has in recent settlements been considered a scientific process and the work of an expert. The object was to bring together under one name all similar soil in the pargana, so that a general rate could be applied to it. Our object is to mark off in each village the *Goind* and *Miyáná* which the people of that village recognize as affecting rent. It is unimportant to us whether what is called *Goind* in one village is as good as what is called *Goind* in the next village. The demarcation, therefore, no longer demands the services of an expert. All we have to guard against is the dishonesty of the *zamindars* and *patwaris* in writing down as *Palo* or *Miyáná* land which pays the *Goind* rate of the village. The *patwaris* record the rent-rate of each field on the *parcha*, and the demarcation should follow the rate.

6. In some villages it will be found that the people pay an all-round rate, and have no separate rates for the three tracts. Yet in these villages they recognize the tracts, and they should be demarcated.

7. The tendency of the *munsarims*, who were employed by the Settlement in Deoria to check the survey classification, was to consider themselves experts, and to put down as *Goind* and *Manjhar* what they themselves considered as *Goind* and *Manjhar* rather than what the people recognized as such. Your staff is quite as competent as any which I can supply to check the dishonest propensities of the *patwaris*, but they must clearly understand that if the work of checking the demarcation is made over to them, they must not consider themselves experts. I propose this season to appoint no *munsarims* to check conventional soils and to leave the demarcation entirely in your hands. The result will, I trust, give us the soils actually recognized by the people, free from all admixture of a so-called scientific demarcation, showing not what are, but what ought to be recognized.

Copy of letter No. 79—IA 6, dated Gorakhpur, the 1st December 1884, from the Settlement Officer, Gorakhpur, to the Deputy Superintendent of Survey, No. 5 Party, Gorakhpur.

I HAVE the honour to forward a copy of the revised rules for working the survey and settlement, which have been agreed upon after discussion between you and Mr. Longe, myself, and Deputy Collector Ashfaq Hosein. The rules include the entire procedure up to the fairing of the record, but I have thought it well to exhibit the entire procedure in one paper, that you may know exactly what we propose to do, after we receive the papers from you. If we find that either department is doing unnecessary work, we may adopt a more perfect division of labour. Your experience and that of your assistants will show you where changes or amplifications of the present rules are required, and by the time the attestation of Bansgaon is finished, we should be in possession of as practical a set of rules as the subject admits of.

Revised rules for the working of the Settlement and Survey in Gorakhpur, 1884-85.

1. The Settlement will demarcate the villages and prepare the *khewat* in advance of the survey.

2. At time of survey all undisputed entries will be made by the *amin* and the *patwari* in their respective *khasras*, and by the *patwari* in the *parchas*. If any entry is disputed, the entry will be made in both *khasras*, and in the *parcha* in red ink. The entry to be made is that which the *patwari* says is right, and he is responsible for the entry. At the same time, the *amin* and *patwari* will enter the field as disputed in their respective list of disputes.

3. The Deputy Collector and some Settlement *munsarims* will move about inspecting the work and enquiring into the cause where there are many disputes. The Settlement does not consider it part of its duty to settle disputes during the survey, but only to see that owing to disputes the work be not stopped or hindered. In many cases it will be found, however, that the disputes raised are such as can be best settled on the field. For instance, there may be a dispute about the division of a field, and this can be settled at once by dividing the field; or a large crop of disputes may arise owing to the *amins* working with defective *khewats*. A village may be recorded as *zamindari*, and be really *pattidari*. In cases like these, the Deputy Collector and his assistants, by discovering the cause of the disputes, will be able to put an end to many. When disputes are thus settled, the *munsarims* will note what they have done in the dispute lists, but they will not write in the *khasras*, and no entry which has once been put in in red in the Urdu *khasras*, shall afterwards be written over in black.

4. In short, whereas formerly the Survey left disputed entries blank to be filled in by a dispute *munsarim*, there will now be no blank entries; but all disputed entries will be in red, and the *patwari* will be responsible for them.

5. The demarcation of soils both natural and conventional, has been entirely made over to the Survey. As soon, therefore, as the *Khanapuri* is finished, and has undergone the checks to which it is submitted by the Survey, the papers can be at once sent to the camp office. We thus avoid all delay in getting blank entries filled in, and the papers are not sent backwards and forwards between the survey and settlement officials for the settlement of disputes or for the demarcation of soils.

6. The first work of the Survey in office is to make a tracing of the map in Hindi figures, and to enter the field areas in both of the *khasras*, and in the slips. The dispute lists should also be compared to see that disputes have not been omitted.

It must then be ascertained that the totals of the two *khasras* agree with each other, and with the totals of the slips. This can only be done after the slips have been arranged and a list of holdings or *terij* has been made out. This *terij* should be in Hindi, for the Hindi *khasras*, as will be explained hereafter, remains with the *patwari*, and the fairing office requires a list of names in Hindi, in order that names which are ambiguous in the Urdu alphabet may be correctly written. This list of holdings will be arranged in *jamabandi* form according to *thoks* and *pattis*, and within them according to—*sir*, *khudkasht*, ex-proprietary tenants, occupancy tenants, tenants-at-will, rent-free tenants.

7. The Survey will then send to the Deputy Collector attached to the camp the following papers:—

(1) The map with Hindi figures.
(2) The Hindi *khasra*.
(3) Both dispute lists.
(4) The slips arranged according to the *terij*.
(5) The *terij*.
(6) The *khewat*, which the survey *amin* has got from the *patwari*.

A column in the *terij* will be left blank for the serial number of the holding. This will be added by the Deputy Collector. The Survey will arrange the various classes (occupancy tenants for instance) in alphabetical order, but some changes may be necessary.

8. On receipt of these papers the Deputy Collector will send the map, the Hindi *khasra*, and the Hindi dispute list to the *patwari* with directions that he should write a note upon separate papers about every dispute. The *patwari*, however, will not put a pen to the *khasra* or the dispute list.

9. Meanwhile the Deputy Collector will cause a *jamabandi* to be made in Urdu from the slips. It is necessary to make this *jamabandi* for several reasons. *First*, it is necessary to guard against the loss of a slip; *secondly*, the Deputy Collectors and *munsarims* cannot work rapidly and confidently with papers in the Hindi character; and *thirdly*, space is required on which to record attestation notes. After comparison with the slips, this *jamabandi* and the slips will be taken by a *muharir* to the village. The *muharir* will read out the *jamabandi* to the collected *zamindars* and tenants. Where the holding is free from dispute he will record in the note-column of the *jamabandi* that the *zamindar* and tenant agreed that the tenant held so much land (five bighas) on occupancy or non-occupancy tenure, as the case may be, at so much rent (ten rupees). It is not sufficient to write that the *zamindar* and the tenant agreed to the entries of the *jamabandi*. The land tenure and rent must in every case be specified in words. The *muharir* will make any other changes to which the people agree, taking the signatures of the parties and of the *patwari* to the alterations. The slips, after correction, will then be left with the *patwari*, with orders to explain to any one who desires it any entries which they may wish to verify. The *jamabandi* will be brought away by the *muharir* and handed to the *munsarim* to whom he is subordinate.

10. The *munsarim* will allow at least a week to pass after he receives the *jamabandi* before he goes to the village. He will take with him the *jamabandi*, the Urdu *khasra*, the Urdu map, the Urdu dispute list, and a blank form of dispute list which will be supplied to him. The people will be collected, and the *patwari* will attend with his *khasra* map, dispute list, and notes on disputes. He will also have the old *jamabandi* for reference. The *munsarim* will take the Urdu dispute list of survey, and mark off on it all disputes agreed to be settled before the *muharir*, ascertaining that they have been settled, and signing his name. All other disputes he will transfer to his own list, and proceed to enquire into them. He will record in the proper columns the substance of the *patwari's* note, and his own conclusion, and the grounds of it. New disputes which arise will be added to the list, and a conclusion come to on each of them, the reasons of the conclusion being briefly recorded opposite each dispute. The *jamabandi parchas* and Hindi *khasra* will be brought into agreement, and the *parchas* will then be distributed. A list of names will be made out and signed by *patwari* and *munsarim*, showing how many *parchas* have been given to each person. Dissatisfied persons will be informed that they must apply to the Deputy Collector on plain paper within 15 days.

11. After 15 days the Deputy Collector will proceed to attest. Each cultivator will be called on to state how much land he holds, at what rent, and on what tenure. As the attestation proceeds, a memorandum of orders on a printed form will be prepared showing the decision of the Deputy Collector on every dispute that is raised. If at attestation any changes are made in rents, rates, or tenures, the alteration in the *jamabandi* must be made in words and not in figures, and must be initialed by the Deputy Collector's *munsarim*. All formal objections on which an order is passed must find a place in the memorandum. On the last sheet of the *jamabandi* the attesting *muharir* and the attesting *munsarim* will write their names and designations in full, as well as their ordinary signatures. The Deputy Collector's *munsarims* will do the same, so that it may be known to whom the signatures on the record belong. The Deputy Collector will initial each page of the *jamabandi*, that no leaf may be hereafter removed.

12. After the Deputy's attestation, the Hindi *khasra* should be altered to agree with the result of the changes marked in the memorandum of orders, and should then be returned to the *patwari*. The *jamabandi* should be sent to be faired. The *parchas*, after correction, should be given back to the owners. New *parchas* will be prepared where the old *parchas* have been much altered. Any imperfect partitions agreed on at attestation will be shown in the *jamabandi*. The map should never be taken from the *patwari* from the time it is given to him. The Hindi dispute list is mainly useful to obtain the *patwari's* notes on disputes before attestation.

13. The object of this procedure is to obtain a complete record of all changes made subsequently to survey. Disputes are unmistakeably shown by the Survey in red ink, and the history of every dispute can be traced in one or other of the three dispute lists. At present,

it is a common ground of appeal that an objection was made, but was not listened to. It is often difficult to discover whether their statement is true; but with proper dispute lists it will be easy. The dispute lists therefore have acquired a much greater importance than was at first attributed to them, for now the Urdu *khasra*, with the result of the dispute lists, should agree exactly with the attested and faired *jamabandi*.

14. The position of the Urdu *khasra*, thus therefore has been changed. It is the record of the work of the Survey, and the dispute lists are the record of the work of the Settlement: the two sets of papers combined are exhibited in the attested *jamabandi*, which is the settlement record. So far as the *khasra* contains statistics of areas, soils, groves, wells, and such like, it is a record of undisputed facts, which are accepted without further check by the Settlement. It should not be looked at to discover the owner or tenant of a field. This can only be ascertained from the attested *jamabandi*. It is evident that for the facts of survey it is preferable to refer to the original paper than to a copy. It is proposed therefore not to fair the *khasra*, but to bind it in with the dispute lists in original, and deposit it in the Collector's office. No change therefore will be made in the Urdu *khasra* after it has been received from the Survey, nor will a copy of any entries in it be given. The only copies that will be given as regards holdings will be from the attested *jamabandi* and from the Deputy's memorandum of orders.

15. It is now time to retrace our steps to paragraph 7, to the juncture when the Survey has sent the unattested record to the Settlement. The Survey has retained only the Urdu *khasra*, but from this all the statistics required for assessment can be compiled.

They are—

(1) The area statement, showing details of cultivated, culturable, and barren.
(2) Agricultural statistics.
(3) Crop statement.
(4) Caste statement of actual cultivators.
(5) Soil statement showing the soils as held in *sir* and *khudkasht*, and by tenants.
(6) Statement of holdings.

16. The last statement has already been prepared by arranging the *parchas* as described in paragraph 6. This statement will be changed after attestation, but the totals of the attested holdings will not be available in the cold weather after survey, when assessment begins, and it is no extra labour to the Survey to supply it.

17. The fifth statement shows the soils as held by owners and tenants. Under the orders of Government, owners' land will be rated at four annas in the rupee less than tenants' land. It would be possible to dispense with this detail, and to have one statement showing the soil areas without any classification of owners' land and tenants' land. To give this classification however is very little extra labour; merely that of making entries in three columns instead of one, and it is a great help to the assessing officer to know whether the *sir* lands are in the *goind* tract or in the outlying. It is true that at attestation land recorded as *sir* at survey may be changed to tenant's land and *vice versâ*, but the changes will not be extensive, and the Settlement Department will not make out any statistics affecting soils.

18. The caste statement shows the area held by each caste and the number of their holdings, irrespective of whether the cultivator is an owner or a tenant. The other statements relate to facts which will not undergo any change at attestation. The assessment statistics will be finished as soon as possible after the record has been sent to the Deputy, and the statistics in vernacular will then be sent to the office of the Settlement Officer; the Urdu *khasra* and a trace in Urdu of the map being forwarded to the Deputy Collector.

J. J. D. LaTouche,
Settlement Officer.

The 1st December 1884.

Extract from the Official Report of the Calcutta International Exhibition, 1883-84.

The Survey of India Court occupied about forty running feet of the centre part of the eastern verandah in the Indian section, and contained a most interesting and extensive series of exhibits illustrating the operations of the survey in its different branches—Trigonometrical, Topographical and Revenue—as well as the processes by which the results of these operations are reproduced and printed in the head-quarters offices at Dehra and Calcutta.

All surveys are dependent on the use of instruments for observation and measurement, and though the collection of instruments exhibited was not so complete as might have been possible had the conditions of space and scale been more favourable, a few of the finest and most representative instruments used in the surveys were shown in two large cases, one at either end of the Court. In the case at the north end was a magnificent zenith sector manufactured by Messrs. Troughton and Simms from designs made specially for the Survey Department by the late Colonel Strange, R. E. The instrument is intended for the determination of astronomical latitudes, and every portion of it has been carefully designed and adapted for this special purpose. In the same case was exhibited one of the large 36-inch theodolites employed in the principal triangulation carried on by the Great

Trigonometrical Survey. This instrument, also, was constructed by Messrs. Troughton and Simms, some 54 years ago, and, notwithstanding its bulk and difficulty of transport, has during that time done good service, having been erected at no less than 516 stations of the Great Trigonometrical Survey, many of them situated on mountain summits, and others on lofty towers. No less than 1,772 angles have been measured with it. This instrument is the largest size of theodolite made, and is used exclusively for triangulation. In contrast with it stood close by a little 3-inch theodolite manufactured by Casella, which is the smallest made, and is intended for the use of explorers.

The instruments exhibited in the other case were of a more miscellaneous character, comprising a Repshold's magnetic dip circle; a 14-inch vernier theodolite of excellent design, by Troughton and Simms; a 7-inch theodolite, with stand, by Cooke; a 20-inch level by the same maker; an arithmometer and other instruments. Among the latter was an Eckhold's omnimeter, a most useful instrument, which, while answering the same purpose as an ordinary theodolite, which it resembles in appearance, is constructed to determine directly the distance of any observed object, and it is therefore a valuable assistance when working in hilly and broken ground.

Between the bays of the west wall and in albums on a table below it were exhibited a very complete collection of maps of various kinds and on different scales produced by the department, as well as specimens of copper-plate engraving, photo-zincography, and lithography.

At the extreme right were cadastral maps, *i.e.*, village maps on the scale of 16-miles to the inch showing every field and holding. Up to the present time the operations of the cadastral surveys have been chiefly confined to the richly cultivated revenue-paying districts of the North-Western Provinces and British Burma, but they are now being extended to Assam and the Central Provinces. The original sheets of these surveys (Imperial size, or 30″ × 20″) are reproduced by photo-zincography, and one of the most interesting exhibits in the Survey Court was a series illustrative of the processes employed in reproducing these maps. The sheets are photographed on glass plates 34 inches × 22 inches, so that a whole sheet is taken at one operation, and much time and labour—important considerations, when 3,000 to 4,000 such sheets have to be reproduced annually—are saved.

Next to the cadastral maps were a series of topographical maps on various scales, seldom larger than 2 inches to the mile, and generally 1 inch to the mile in open country and ½ inch to the mile in more difficult and hilly parts. These surveys, as a rule, are carried on in native states and wild hilly tracts not paying revenue. The original sheets submitted by the surveyors in the field are reproduced in *facsimile* by photo-zincography, either at Dehra Dún or in Calcutta. In the same way the maps of the revenue surveys in the more highly cultivated revenue-paying districts are usually published on the scale of 1 inch to the mile, the more recent surveys being photo-zincographed, and the older, lithographed.

In the next bay were exhibited specimens of town and city plans, chiefly European stations and cantonments, but also including plans of the principal cities in Native States. These are on various scales from 6 to 24 inches to the mile, and are executed by the revenue and topographical parties, according as the towns, &c., fall within their sphere of operations. These also are, as a rule, photo-zincographed from the originals.

Next came a collection of General Maps, among which the most prominent was General Walker's admirable map of Turkestan on the scale of 32 miles to the inch, now in its 6th edition, prepared and photo-zincographed at the Trigonometrical Branch Office, Dehra Dún. In this bay was also exhibited a series of maps of India, engraved in Calcutta on the scales of 64, 128, and 256 miles to the inch. A large 32-mile to the inch map of India, belonging to the series, was exhibited separately. It was executed by a combination of engraving and lithography, the outline being taken from the engraved plates and completed with the addition of hills on the lithographic stone.

The next three bays were occupied by specimens of copper-plate engraving, lithography, and photo-zincography in different styles and of various subjects other than maps, illustrative of the varied character of the work turned out by the Survey Department for other departments. Thus among the engravings were a few very delicately engraved plates by Mr. C. W. Coard, of microscopic observations of cholera, and of examination of air made by Drs. Lewis and Cunningham. Among the photo-zincographs were copies of the plans of the proposed new Kidderpore Docks, plans of some of the new public buildings in Calcutta designed by Mr. E. J. Martin, the Government Architect, and a few copies of engravings, &c., while contained in the atlases on the table were specimens of the different kinds of vernacular handwriting passing through the Post Offices in India, photo-zincographs of the ancient inscriptions in Gaur and Malda, copies of Burmese vernacular maps, Russian maps, and other manuscript drawings and documents of which *facsimile* copies are required.

The specimens of lithography and chromo-lithography were particularly good, the execution of some of the geological maps printed in colours being quite equal to similar work done in Europe. Th chalk-drawings included a number of plates to illustrate General Cunningham's reports of the archæological survey and a large and very effective plan of Simla and Jutogh with hills in chalk, copied from an original brush-shaded drawing by Major G. Strahan, R. E. The atlases on the table contained various specimens of lithographed maps and drawings, among which may specially be noticed some very neat maps of districts in the North-West Povinces drawn on stone to illustrate the Provincial Gazetteers.

One of the most noteworthy exhibits was the large relief map of India on the scale of 32 miles to the inch, constructed by Major G. Strahan, R.E., on the basis of a map, also prepared by him, showing the approximate heights by a system of average contours. Prints of this map on stout paper being cut round each contour, they were built up so that each successive contour marks an increase in height on the relief. The first five contours, reckoning from the level of the sea, represent successive rises of 200 feet. From 1,000 feet upwards each contour represented an increased height of 500 feet. The general effect was very striking, and the lie and elevations of the mountain ranges were very different from what would have been anticipated from a study of the ordinary maps.

A very important and interesting series of thirteen large maps, of which ten were prepared specially for the Exhibition, illustrating the material progress and state of India, was shown on the last wall of the Court, and attracted a good deal of attention. The subjects illustrated in these map were—

The Geology of India; the Distribution of Forest Trees; the Missionary Stations (and from the numerous enquiries made for copies of it, this appeared to be by no means the least interesting); the Religions of India; the Telegraph Lines and Stations; the Crops; Irrigation; the External Trade; Density of Population; Rainfall; Languages; and River Basins.

The Crop map was prepared by Captain Gore, R.E., under the direction of Colonel DePrée, Surveyor-General of India, on a very simple and ingenious system, and showed the acreage under cultivation of the eight principal crops in each district, as given by returns furnished by district officers. Each district was divided on the map into ten vertical slips, each slip, whatever its length, being taken to represent one-tenth of the area of the district. The slips or portions of slips were coloured to show the percentage of area under cultivation with the eight principal crops. The area of uncultivable land was also shown. The area in acres of each district was printed across it, so that it was possible to calculate at once the area of any crop growing in the district. Unfortunately the absence of statistics for the Bengal districts rendered the map incomplete.

The map showing the distribution of the various religions in India, prepared by Major Sandeman, was also very interesting. The occurrence of the various religions was shown by spots of colour thus—Islam, green; Hinduism, burnt sienna; Christianity, blue; the Sikh's religion, red; Buddhism, yellow; &c, each spot representing 25,000 inhabitants. The map showed therefore not only the distribution of the various religions, but the density of the population. The last characteristic was specially marked in the Gangetic valley. The large preponderance of Muhamadans in Bengal was also clearly shown, while in Southern India the blue spots, representing Christianity, occurred with comparative frequency.

The geological map and the rainfall map were lithographed from originals prepared in the Geological Survey and Meteorological offices, and were good specimens of colour printing. It is to be hoped that the whole series of these interesting maps will be lithographed and made available to the public, as a glance at them teaches more as to the actual state of the country than volumes of dry statistics.

For this very comprehensive collection of maps a gold medal was awarded to the Survey of India.

The two large tables with sloping backs running along the centre of the Court were chiefly devoted to photographs and specimens illustrating the processes of photo-mechanical printing and lithography. Among the former the most important were a small collection of the photographs of the sun's disc taken daily in the photo-heliograph at Dehra Dún under the superintendence of Mr. J. B. N. Hennessey, M.A., F.R.S., to which a silver medal was awarded. These photographs, though not so large as those taken by M. Janssen at Meudon, near Paris, being only 8 inches in diameter instead of 12 inches, showed the granulation of the solar surface very clearly, and in this respect were a great improvement on the 4-inch photographs hitherto taken. Arrangements are now completed by which 10-inch photographs are taken. These show the granulations and spots with great clearness

The remaining photographs were exhibited by the Photographic office in Calcutta, and comprised reproductions by the ordinary silver-printing process of monochrome drawings by Colonel H. C. B. Tanner, R.E. s. c., and a small series of photographs of Indian jewelry, &c., prepared for the Vienna Exhibition of 1872. Among the illustrations of photographic processes the most noteworthy was a series showing the procedure followed in photo-zincographing a sheet of the cadastral survey:—

1*st.*—The original manuscript map, drawn in the field, measuring 22 × 30 inches.

2*nd.*—The negative, taken by the ordinary wet-collodion process on a glass plate 34 × 22 inches, special precautions being taken to keep the lines of the map as clear as possible, while the ground is quite black and opaque.

3*rd.*—The photo-transfer print from the negative, produced by sun printing on sensitive paper coated with a mixture of gelatine and bichromate of potash, the image formed by the action of light through the clear parts of the negative appearing in brown upon the pure yellow ground of the paper protected from light by the opaque parts of the negative.

4*th.*—The transfer print, coated evenly with a greasy transfer ink, which blackens it all over.

5*th.*—The photo-transfer print after washing in warm water. The ink and unchanged gelatine and bichromate are washed away from the ground of the print, leaving the image in insoluble gelatine with the greasy ink attached.

6*th.*—The zinc plate with the greasy ink image transferred to it.

7*th.*—The finished print.

This process, introduced in 1863, is most extensively used in the Survey of India offices, both at Calcutta and Dehra, for the reproduction of maps. The great majority of the maps exhibited were produced by means of it, and no other process would enable the department to meet the large demands upon it for copies of maps, plans, and drawings of all kinds.

The other two photo-mechanical processes exhibited were photo-collotype and heliogravure. These, though eminently useful for certain classes of work, will never supersede photo-zincography for the rapid and cheap reproduction of large maps.

The process of photo-collotype was shown by a series comprising—

1*st.*—The original, an engraved quarter-sheet of the atlas of India.

2*nd.*—A reversed negative made from the original reduced to half the scale.

3*rd.*—The printing plate, consisting of a plate of glass, half an inch thick, coated with a thin film of hardened gelatine. This film is made sensitive to light with bichromate of potash, and when dry is exposed to light under the negative. The light passing through the clear parts of the negative, representing the shadows of the subject, still further hardens the gelatine, and renders it unabsorbent of water just in proportion to the amount of the action of light upon it. The plate is then washed to remove all the bichromate salt, and removed while wet to an ordinary printing press, where it is inked in with a roller charged with printing ink, just in the same way as a lithographic drawing. The ink will take only on the parts hardened by the light, and if the subject be in half-tone, such as an ordinary photograph, the ink will take just in proportion to the amount of action of light—strongly on the deep shadows, less so on the dark half-tones, less again on the lighter half-tones, and not at all on the high lights, and thus a picture is obtained in printing ink with all the exquisitely fine gradation of an ordinary photograph.

A collection of specimens of this process showed its capability of reproducing various subjects in fine lines or half-tones, and it may be mentioned that it was employed for the production of the certificates of award of gold medals, photographed from the original drawing by A. P. Bagchi of the School of Art.

Another valuable photo-mechanical process shown, was *heliogravure*, a method of photographic engraving by which an engraved copper plate may be obtained of any subject in line or half-tone. The process consists in printing a photographic image on a tissue prepared by coating paper with coloured gelatine and rendering it sensitive by immersion in a bath of bichromate of potash. The printed tissue is then made to adhere under water to a polished copper plate thinly silvered. After a short time the plate with the tissue is treated with warm water which loosens the supporting paper and enables it to be removed, leaving the greater part of the coloured gelatine and the image on the copper plate. By continuing the washing all the soluble gelatine is removed, leaving only the thin film of gelatine forming the image and rendered insoluble and hardened by the action of light. This film is of varying thickness according to the amount of the action of light. It is thickest in the deepest shadows of the image, and progressively thinner through the dark and light half-shades down to the high-lights, which should be represented by the bare copper.

If the subject be in line, no further treatment of the gelatine relief is necessary beyond a slight hardening in a bath of alum or bichromate of potash, after which it is washed and dried before being black-leaded and prepared for electro-typing.

If, however, the gelatine relief be produced from an ordinary photograph, or any other subject in half-tone, it has to undergo a further operation by which a grained or roughened surface is given to it, in order that the surface of the deposited copper-plate may also be roughened, and hold the printing ink in the proper proportion to give the relative value of the different tones of the picture. This is done by a method introduced by Major Waterhouse, which has proved simple and effective. After the treatment with warm water, and while the gelatine relief is still soft and swollen, it is powdered all over with some granular material, such as sand or emery, which has been previously treated with a greasy substance to prevent its sticking to the gelatine. The plate is left to dry, and as it dries the sand, &c., is drawn into the gelatine and pits its surface in different depths according to the thickness of the film, thus producing a graduated grain, coarse in the shadows and fine in the lights. The plate being wetted, the sand is easily removed by gentle rubbing. When dry, the grained relief is ready to be black-leaded and electro-typed—an operation which takes about three weeks or a month, according to the thickness of the deposit. The deposited copper is then separated from the matrix, and after being cleaned is ready for printing in the copper-plate press.

The series exhibited showed—

1*st.*—The original, which in this case was a drawing in monochrome by Colonel C. J. Cramer Roberts of a view of Kinchinjinga from Birch Hill, Darjiling, represented by a photographed copy.

2*nd.*—The negative, which has to be reversed in order to produce a reversed image on the deposited plate.

3*rd.*—The gelatine tissue adhering to the copper plate.

4*th.*—The developed and grained image.

5*th.*—The same black-leaded and ready for electro-typing.

6*th.*—The deposited copper plate ready for printing.

7*th.*—The proof from the plate.

In a frame were shown various specimens illustrating the applications of this process to copies of maps, shaded drawings, portraits, and views from nature.

On the same side of the table was a small series comprising a stone with outline in black; three colour stones with proofs of each colour, and the completed copy of an index map of the Geological Survey, illustrating the process of printing in colours by lithography.

Gold medals were awarded to both the Photographic and Lithographic Offices for the excellence of their exhibits.

On the other side of the central table were an array of imposing-looking volumes recording the operations of the Great Trigonometrical Survey, and prepared under the immediate superintendence of Lieutenant-General J. T. Walker, C. B., R. E., late Surveyor-General of India. The annual reports of the department which, it may be mentioned, contain a vast quantity of interesting and valuable information regarding little known parts of the country, were shown with other reports.

The last exhibits requiring notice are the tidal diagrams on the central table illustrating the very important work done by the Tidal and Levelling party of the Great Trigonometrical Survey under Major Baird, R.E. The tidal observations were first started in 1872 with the object of ascertaining by a series of observations extending over many years whether any gradual difference of relative level of land and sea is taking place in the Gulf of Cutch, as was surmised by the late Dr. Oldham, Superintendent of the Geological Survey, and the early operations of the party were confined to that neighbourhood. The tidal observatories have, however, since been extended round the Coast of India and British Burma from Kurrachee to Moulmein, and there are also stations at Aden and at the Andaman Islands. The observations are effected by self-registering instruments, which record the rise and fall of the tides in a curve upon a sheet of paper rolled round a metallic drum. Besides their scientific value in determining variations of the level of the land and sea, these observations are of considerable practical use in enabling tide-tables to be drawn up for the different Indian ports for the use of mariners. They have also been found very valuable to science in another direction, as giving records of earthquakes and other submarine volcanic disturbances taking place in Indian seas. Thus the earthquake of the 31st December 1881 was clearly recorded at Port Blair, Negapatam, and other stations on the east coast of the Bay of Bengal. The effect of the more recent volcanic eruption of August last in Java was also distinctly traceable on the registers of most of the Indian tidal stations, extending as far as Aden.

This slight sketch of the various interesting exhibits of the Survey of India can only give a very faint idea of the extent of the operations of the department in its several branches, and of the steady progress that is being made in accurately mapping this vast empire. Although the lines of tringulation, upon which so much depends in survey operations, have now been almost completely fixed all over the country with an accuracy equal, if not superior, to that of any country in the world, and much has also been done in the Topographical and Revenue branches to get a good general first survey, much detail work still remains, and there are yet many openings for valuable explorations on and beyond the frontiers and in other little known regions.

W. J.—Reg. No. 10543J—400—30-4-85.

ERRATA ET CORRIGENDA.

On pages (18) to (40) of Appendix to the General Report of the Operations of the Survey of India Department, during 1882-83.

Page				
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(34)	„ „ 3 from top, col. 2	„	4°·752	„ 47°·52
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(39)	line 2 from bottom	„	4·697	„ 5·697
(40)	in table, line 5 from top, col. 9	„	309°·35	„ 309°·85

Circular No. $\frac{1178.}{98-2}$

Extract from the Proceedings of the Government of India in the Revenue and Agricultural Department (Surveys),— dated Simla, the 12th September 1885.

Read—

The General Report on the Operations of the Survey of India Department for 1883-84.

RESOLUTION.

Several changes took place in the *personnel* of the Survey Department of India during the year under report, of which the principal were due to the retirement from the service of the Government of Lieutenant-General J. T. Walker, R.E., C.B., and Mr. J. B. N. Hennessey, M.A., F.R.S., late Deputy Surveyor General in charge of the Trigonometrical Branch. The Government of India has already recorded its appreciation of the long and distinguished services rendered to the Department by the former officer, and His Excellency in Council has observed with satisfaction that Her Majesty the Queen-Empress has been pleased to recognize the valuable scientific work done by the latter by conferring on him the companionship of the Order of the Indian Empire. PERSONNEL.

2. The results of the working of the three Branches of the Department are described in Part II. of the report.

3. The Secondary Triangulation Party visited and erected beacons on the old stations of the East Coast Series, from Puri to Balasore. The positions of the beacons and buoys of False Point Harbour and the Dhamra river were accurately fixed, as were those of all prominent objects on the coast which could be used as land marks for ships. This work will, it is hoped, facilitate navigation and the future work of the Marine Survey. TRIANGULATION.

The connection by triangulation of the Peninsula of India with the Straits Settlements and Malacca has been held in abeyance during the year, and it has recently been decided in view of financial exigencies that it shall not be undertaken for the present.

4. Eleven Topographical parties were employed. Of these three were in the field in Bombay, two in the North-Western Provinces, and one each in the Andaman Islands, Assam, Baluchistan, Central India, Mysore, and Rajputana. TOPOGRAPHICAL SURVEYS.

5. The three Bombay parties worked in Cutch, Guzerat, and the South Deccan respectively.

In Cutch 2,154 miles were surveyed topographically on the scale of two inches to the mile, and 1,086 miles on the scale of half an inch to the mile, and 2,100 square miles were triangulated in advance. The Guzerat party executed some topographical surveys of Native States on the two-inch scale, and completed the survey of the Panch Mahals on the four-inch scale, including the demarcation of village and forest boundaries. The area already surveyed in Guzerat amounts to 18,191 square miles, or about two-fifths of the whole. In the South Deccan the area surveyed amounted to 1,832 square miles of a more mountainous and difficult country than any with which the party had previously met. It is estimated that the 15,200 square miles, which still remain unsurveyed in the area assigned to the South Deccan party, will occupy about 8 years.

6. The parties in the North-Western Provinces were employed in the Aligarh and Etah districts, and in the Mirzapur district, respectively. In the Aligarh and Etah districts 1,503 square miles were surveyed on th 2-inch scale. The riparian tracts on either side of the river Ganges covering an extent of 98·09 square miles were surveyed on the 4-inch scale. It has recently been decided to suspend the topographical survey of the remainder of the North-Western Provinces and Oudh, the existing revenue maps being

sufficiently accurate to answer the present requirements of the Civil Administration, and topographical surveys of other tracts being more urgently required. The work of the Mirzapur party consisted of a survey of a portion of the district on the 2-inch scale, and the execution of theodolite traversing round the village boundaries of the Dudhi pargana, and certain villages of the hilly tracts of Robertsganj. This work was of a very laborious description, owing to the nature of the country.

7. A suitable map of the South Andaman Island being much needed by the Settlement officers, a party was deputed in November 1883 to make a complete survey of that island. The only datum available on which to base the survey was the position of a point on Chatham Island in the harbour of Port Blair, the latitude and longitude of which had been determined astronomically in 1863. The result of the season's work is a map of Barren Island and the Island of Narcondam on the scale of 8 inches = 1 mile and sheet No. 14 on the 4-inch scale. It has been decided that the survey shall extend to the remainder of the Andaman Islands. The general survey will be executed on the $\frac{1}{2}$-inch scale, though certain portions of the South Andamans will be surveyed on the 4-inch scale. Advantage is being taken of the survey to investigate the geology and flora of the Island.

8. The Assam and North-Eastern Frontier party was originally to have been employed in the survey of the Noa Dihing valley up to the Patkai crest, but the Aka raid on the Darrang district having necessitated the despatch of a punitive expedition against the offending tribes, it was determined to take advantage of the opportunity offered for the Survey of the Aka Hills. Subsequently the Daphla country was also surveyed. The detailed survey executed covers 1,934 square miles of the Aka and Daphla hills on the scale of 1 inch to 4 miles; 622 square miles on the scale of 1 inch = 2 miles and 143 linear miles of route and river survey by native explorers within British territory.

9. The Baluchistan party was divided into three sections, of which one was employed with the Takht-i-Sulaiman Expedition; one accompanied Sir R. Sandeman's Mission into South-Western Baluchistan, and one was employed on the regular detailed survey. The area triangulated amounted to 6,100 square miles, and the area topographically surveyed to 4,840 square miles on the half-inch scale. This work was carried out in the Thal-Chotiálí territory and the Kachi desert.

10. The Malwa party executed 1,390 square miles of triangulation and 1,587 square miles of detail survey on the 1-inch scale besides completing the triangulation and traversing for the large scale survey of the Dúngarpur city and the Kherwára cantonment. The country is intricate and much cut up by small streams and hillocks. The party has now completed its work, and a portion of it will, during the ensuing field season, probably be sent into Ajmere, the remainder being transferred to Bengal.

11. In Mysore 1,417 square miles, including the work required as a basis for the Mysore city survey, were triangulated. The area topographically surveyed on the 1-inch scale amounted to 3,975 square miles in the districts of Shimoga, Kadur, Mysore, and Bangalore.

12. The Rajputana party was chiefly employed in surveying on the scale of 1 inch=1 mile portions of the Sirohi and Palanpur States and the sanitarium on the Abu Range. The Sunda and Dorra ranges were surveyed on the 2-inch scale; and the revised survey of the city and environs of Ajmere was nearly completed for the Municipality on the scale of 12 inches = 1 mile. The total area surveyed was 1,211 square miles on the 1-inch scale and 120 square miles on the 2-inch scale, besides the 12-inch survey of Ajmere city; 4,133 square miles were also triangulated.

MAUZAWAR, RIVERAIN AND FOREST SURVEYS.

13. Three parties were employed in mauzawar, riverain and forest surveys in British Burma, the Punjab and Bombay, respectively. The first-named party surveyed 211 square miles of reserved forest tracts on the scale of 4 inches = 1 mile; and 52 square miles of unreserved forest and ground likely to be brought under cultivation on the scale of 2 inches = 1 mile. The area prepared in advance for next season was 321 square miles. The surveyed area lies on the western slope of the Pegu Yoma range in the Tharrawaddy district. The

country is very difficult for survey on account of the almost impenetrable undergrowth and the rugged, and in many parts inaccessible, character of the range. The several high ridges running parallel to the range are covered with forest, and intersected by streams while the Yoma or back-bone of the range stands up like a wall above the lower hills. In a part of the Thonze reserve a rise of more than 2,000 feet occurs in a little more than a mile from the crest.

14. The party employed in the Punjab continued its previous year's work in Hissar of a topographical survey on the 2-inch scale, combined with a system of skeleton traverses to aid an approaching settlement survey. In the report the system followed is thus described :—

"The traversing follows village boundaries, in the interior of which sub-traverses are run at distances of about ½ a mile apart, furnishing fixed points at short intervals, all of which are permanently marked. From the data obtained of these points, skeleton plots can be prepared on any required scale, these will furnish an efficient frame-work for the cadastral survey of fields to be undertaken by the *patwaris* of the district under the superintendence of the Settlement Department.

The object of the Hissar experiment is to ascertain by actual trial in what way the Settlement and Survey Departments can best assist each other. While it is hoped that the survey skeletons will on the one hand form a frame-work for patwari field maps, so on the other it is expected that the details furnished by the field maps will be incorporated in the topographical maps. A fuller report on this subject is expected in the Surveyor General's Report for 1885-86, as at present there is no reason to believe that the work of the survey party is to be made in any way the basis of patwaris' maps, as was intended by the Government of India.

The areas surveyed comprised 1,782 square miles of the district on the 2-inch scale, the Hissar farm (64 square miles) on the 6-inch scale, and the city and station of Hissar 14 square miles on the 12-inch scale.

On the completion of the survey of Hissar, it had been intended to employ detachments of the party in Ferozepore, Umballa, Jullundur and Ludhiana. The experience gained in Hissar has, however, shown that in the plains districts of the Punjab, so elaborate a system is unnecessary; and in future the operations will consist of a modified skeleton traverse survey, two trijunction platforms being utilized for stations, and fixed in each village, and of a scientific survey of all riverain tracts subject to fluvial action. The topography of revised 2-inch maps of the province will be taken from the settlement maps, the details being tested and additions made where necessary.

15. The third mauzawar survey party was employed in the Thana district of the Bombay Presidency. The work done by it embraced the survey of the Thana Collectorate on the 4-inch scale, and the 2-inch survey of the Jawhar State. On the larger scale, 612 square miles were surveyed and 288 square miles on the smaller. The country surveyed lies between the Western Ghats and the sea, and is very difficult in parts.

CADASTRAL SURVEYS.

16. Cadastral or field survey parties were employed in the Ajmere-Merwara district, in three districts in British Burma, in three districts in the North-Western Provinces, in one district in the Central Provinces and in one district in Assam. The areas surveyed are given in the margin.

North-Western Provinces	1,747	square miles.
British Burma	1,749	„
Central Provinces	31	„
Assam	228	„

The Ajmere-Merwara survey was begun in connection with the revision of the settlement of the district. The fluctuating character of the cultivation rendered an ordinary cadastral survey of the district unsuitable and after consideration it was determined to adopt a system of traverse and village boundary survey, under which fixed points are established by professional traversing, and skeleton maps are provided showing the boundaries of each village and the position of each permanent mark within it. On these data the *patwaris* map in the cultivation at the time of their survey and whenever changes may become necessary.

17. The three cadastral parties in British Burma were employed respectively in the Bassein and Henzada districts, the Pegu and Shwegyin districts, and the Prome and Akyab districts. All the cadastral work required in the

Pegu and Prome districts has been completed; and now only one and a half parties are employed in Burma, half a party having been withdrawn altogether for financial reasons and another party having been diverted to topographical work.

18. In the North-Western Provinces the parties employed worked in the Benares and Basti districts, the Dehra Dun district (a detachment) and the Gorakhpur district.

The so-called Benares system under which the survey and settlement establishments work together, each preparing its own copy of the *khasra* and *jamabandi*, was followed in the Benares-Basti survey. In Gorakhpur a slightly different system has been adopted. There the survey officer furnishes with the map a correct record of all undisputed facts of ownership and tenancy, a complete list of all disputes, and a classification of the soils and statistics for assessment purposes. The Revenue Officer then fills up the dispute list and checks the soil classification. The success of this system in respect both of expedition and economy, when compared with cadastral work hitherto turned out by the Survey Department, has been shown by the result of the operations of the work of the first season. The detachment in Dehra Dun was employed in surveying the cultivated lands on the Benares system.

19. The detachment in the Central Provinces was employed in the Raipur district in the cadastral survey of a certain number of villages as a test of the accuracy of the settlement maps. The survey establishments prepare a skeleton survey of the boundaries of villages, together with those of moderately sized blocks of fields, and the interior divisions are afterwards to be filled in by the *patwaris* who also write up the record-of-rights. A survey class has been organized for the instruction of junior civilians, native officials and *patwaris*.

The arrangements for the survey of the remaining districts of the Central Provinces of which the settlement will expire within the next few years is now under the consideration of the Government of India.

TRAINING OF CIVILIANS, &c.

20. The cadastral survey of the Kámrúp district was begun on the completion of the Hooghly River survey. The Benares system of survey has been adopted in Kámrúp at the instance of the Chief Commissioner.

21. A new system of training young Civilians in cadastral survey work by attaching them to regular field parties has been begun. In the North-Western Provinces, seven Civil Servants have been thus instructed in field surveying; and native soldier students from the Roorkee College have also been attached to the regular field parties of the Topographical Branch, and instructed in the method of delineating ground by plane-table survey.

EXPLANATION OF THE THREE SYSTEMS OF CADASTRAL SURVEY.

22. In explanation of the foregoing paragraphs it may be stated that there are three systems of cadastral survey now at work, one in the Punjab where, except possibly in the case of the Hissar experiment, no use is made of the Surveyor General's Department, all field maps being constructed by patwaris under the control of the Settlement Officer. The actual cost of this work has not been ascertained, but it is believed to be cheap, and sufficiently accurate for revenue purposes, although it has the drawback of not fitting in with sufficient precision into the general survey maps of the country. The next system is that now under adoption in the Central Provinces, where, as already explained, the field plotting will be filled in by patwaris on a traverse skeleton provided by the Survey Department. The third is that in progress in the Gorakhpur and Basti districts of the North-Western Provinces, where the entire survey map of each village together with a considerable portion of the village record is turned out by the Survey Department. This system is the most accurate and complete in its results, but is probably the most expensive, and can only be justified in districts where the patwaris are insufficiently trained to do the field plotting. The Surveyor General is requested to bring forward in his next annual report as clear a statement as he can furnish of the cost and results of each of these systems. The subject of cost is more fully dealt with in paragraph 28 of this review.

GEOGRAPHICAL AND MISCELLANEOUS.

23. Under the head of *Geographical* and *Miscellaneous*, the Darjeeling party surveyed the Sumesar Hills, the Daling Hills, and a portion of Sikkim,

besides triangulating and sketching Himalayan topography and demarcating and surveying the Nepal-Bengal Boundary. Explorations were also conducted in Tibet. This party did some interesting work and has helped towards an extended knowledge of Himalayan geography.

TIDAL AND LEVELLING OPERATIONS.

24. The Tidal and Levelling party has continued its scientific work; tidal observations being taken at 19 stations. The reduction of the observations has progressed steadily, and the final results have been determined, so that the co-efficients will be presented in the manner recommended by Professor Darwin and explained in the Report for 1882-3. The Spirit-levelling operations completed a line of levels between two sea-coast stations, *viz.*, from Kurrachee to Agra and thence to Bombay with an error only of ·624 of a foot or less than 4 inches per 1,000 miles. This line was linked with that of last year and its length was over 425 miles over ground with rises and falls amounting in the aggregate to nearly 22,000 feet.

GEODETIC.

25. The two Astronomical parties were engaged in the extension of the electro-telegraphic longitude arcs eastwards of Calcutta, and measured six arcs during the season—Akyab-Calcutta, Akyab-Chittagong, Prome Chittagong, Prome-Akyab, Moulmein-Prome, and Moulmein-Akyab. The link between Kurrachee and Moulmein was thus completed.

HEAD QUARTERS OFFICES.

26. The work of the Head-Quarters Offices, both at Calcutta and at Dehra is dealt with in Part III. The several offices have again turned out a very large amount of work for other departments and Local Governments. The total number of maps issued during the year amounted to nearly 200,000, and their value exceeded a lakh and a half of rupees. Much good work was done in these offices in connection with the Calcutta International Exhibition. The 3,000 ornamental award certificates were produced with the aid of the heliogravure and collotype processes. Some of the special maps which were drawn for the Exhibition have been prepared for publication and the rainfall, railway and telegraph maps have already been published. Maps showing trade routes, distribution of languages, and river basins have also been printed. Maps showing the density of population and the distribution of the different religions and missionary stations are in course of publication. The forest map is, it is understood, now ready. The Government of India attaches great importance to these maps; and a Crop-map of India, shortly to be prepared, will be completed in time for the Colonial and Indian Exhibition of 1886.

MATHEMATICAL INSTRUMENT DEPARTMENT.

27. The Mathematical Instrument Department issued 33,365 instruments valued at Rs. 1,61,529 to departments. The number issued exceeded that of last year by 12,000, their value being greater by Rs. 34,000. The Government of India is also glad to notice that there has been a considerable use of articles of Indian manufacture for this department. An innovation has been introduced into the department by the entertainment of apprentices in the several technical offices. Their work should be carefully watched; and the result of the experiment should be noticed in future annual reports.

COST RATE PER MILE OF SURVEY WORK.

28. The statements at pages LXXX and LXXXI of the Appendix, showing the cost rate per mile of work executed by the several parties are, as far as they go, very valuable. The opportunity is taken however to impress upon the Surveyor General the very great importance of reducing the expenditure on revenue surveys of all kinds to the very lowest limit as urged in the Resolution of September 4th, 1882. Notwithstanding the comparatively small cost, compared with the charges of former years, of the North-Western Provinces Surveys, the charge is still too high to admit of the system being extended to any Province in which it is possible to utilize patwaris under the supervision of local officers for field plotting. Great credit is due to Majors Barron, Sandeman and Steel for their unremitting efforts to make the cadastral parties serve the Provincial Governments in the most effective manner, but it is now a question whether similar efforts should not, on account of the financial exigencies of the case, be directed to the perfection of a system in which the very utmost use should be made of the village officers for field plotting, under the control of an efficient staff of native supervisors. The fact that the Government, whether Imperial or Provincial, is obliged in any case to provide payment for a village staff, makes it imperative to require the education of that staff in the duty of making and

maintaining village maps so that the cost of a second establishment may be avoided, and it will be found that unless the Survey Department can make the above system the goal of its efforts, it will be difficult for it on financial grounds to maintain that connection with the cadastral surveys still remaining to be accomplished which it is very desirable to preserve. The two points to be aimed at, in modification of the North-Western Provinces system, seem to be the more liberal employment of the village staff, and the reduction of the charges for supervision. The Government of India would be glad if in future reports the information as to "cost" could, with the assistance of the Provincial authorities, be made to comprise a comparison between the total cost of various systems adopted in any districts in which the Survey Department is employed, whether to do the whole work as in the North-Western Provinces, or a part of the work as in the Central Provinces and Hissar. At present the table in page LXXX is not sufficiently instructive. The cost per acre for instance of a complete cadastral survey (including traverse, field plotting, and survey record) in Ajmere cannot be compared with that of a complete cadastral survey in the North-Western Provinces.

29. In conclusion, the Government of India thanks Colonel DePréc for his interesting report.

Order—Ordered, that the above Resolution be forwarded to the Local Governments and Administrations named in the margin; and to the Surveyor-General of India, and to the Foreign and Military Departments for information.

Madras.	Central Provinces.
Bombay.	British Burma.
Bengal.	Assam.
North-Western Provinces and Oudh.	Coorg.
Punjab.	

Ordered also, that it be published in the supplement to the *Gazette of India*.

(True extract.)

E. C. BUCK,

Secretary to the Government of India.

FILE No. 98.
SERIAL No. 2.

1885.

GOVERNMENT OF INDIA.

REVENUE AND AGRICULTURAL DEPARTMENT.

SURVEYS.

RESOLUTION.

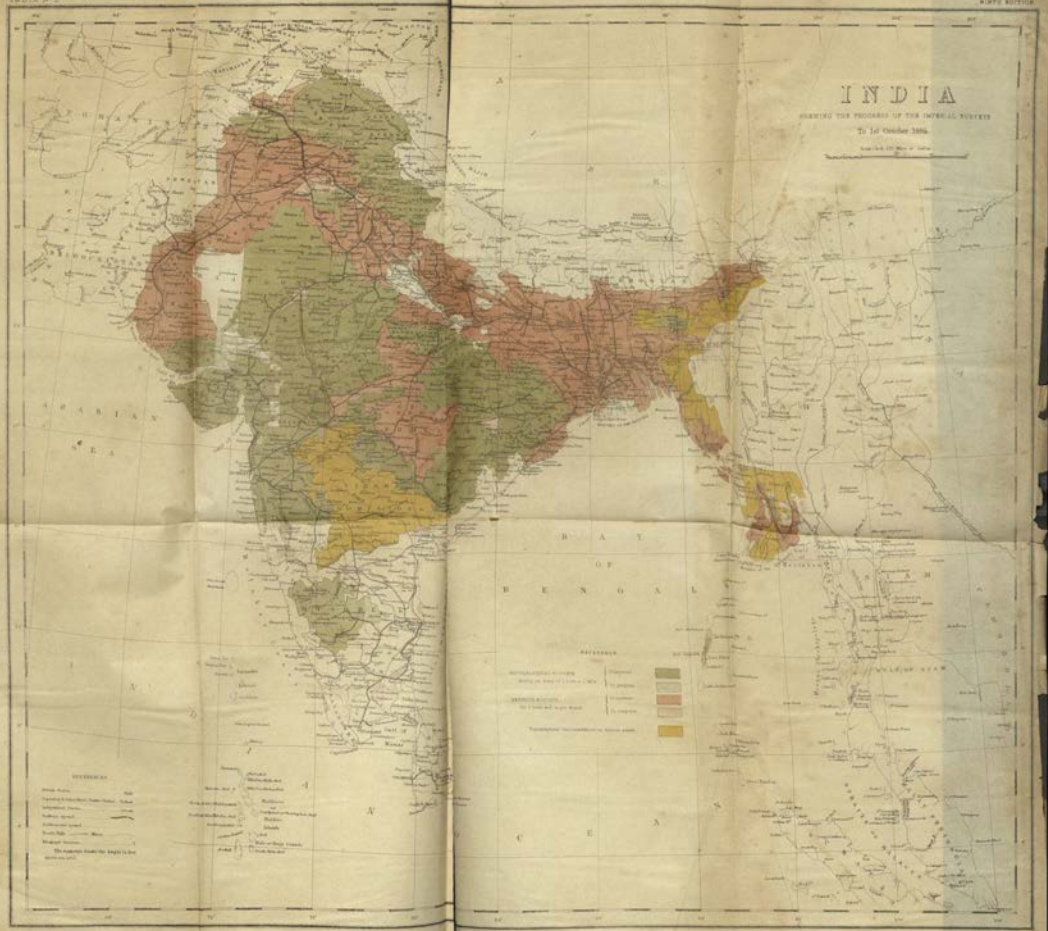
Circular No. 117S.
98—2

Dated Simla, the 12th September 1885.

SUBJECT.

Reviews the Survey Report for 1883-84.

Govt. C. B. Press, Simla.—No. 503 R. & A. D.—15-9-85—1100.


INDIA
SHEWING THE PROGRESS OF THE IMPERIAL SURVEYS
To 1st October 1894.
ARABIAN SEA
BAY OF BENGAL
REFERENCE

INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA
SHOWING COLONEL LAMBTONS NET WORK OF TRIANGULATION IN SOUTHERN INDIA,
THE MERIDIONAL AND LONGITUDINAL CHAINS OF PRINCIPAL TRIANGLES,
THE BASE LINES MEASURED WITH THE COLBY APPARATUS,
THE LINES OF THE SPIRIT LEVELLING OPERATIONS,
THE ASTRONOMICAL PENDULUM & FUNAL STATIONS,
THE LONGITUDINAL ARCS,
AND THE SECONDARY TRIANGULATION IN THE PEAKS OF
THE HIMALAYAN & THE SOULIMANI RANGES,
AND THE POSITIONS OF BANDACH AND KHOSHAM.
REFERENCES
BAY OF BENGAL
LEYLON

GENERAL REPORT

ON THE

Operations of the Survey of India Department,

ADMINISTERED UNDER THE GOVERNMENT OF INDIA

DURING

1884-85.

PREPARED UNDER THE DIRECTION

OF

COLONEL G. C. DEPRÉE, S.C.,
Surveyor-General of India.

CALCUTTA:
PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1886.

CONTENTS.

PART I.

INTRODUCTION.

	Page
Director and Administrative Officers of the Survey of India	1
Statement of Administrative and Technical Officers of the Survey of India Department	3
„ „ Survey Operations and Parties	4
Triangulation	5
Special Operations	*ib.*
Topography	*ib.*
Riverain and Forest Surveys	6
Cadastral and Traverse Surveys	*ib.*
Geographical Exploration	8
The Index of Trans-Frontier maps and Military map of India	9
Honours and Rewards	10
General Remarks	*ib.*

PART II.

SUMMARY OF THE OPERATIONS OF THE TRIGONOMETRICAL, TOPOGRAPHICAL, REVENUE, AND EXPLORATION SURVEY PARTIES.

	Page Report.	Page Appendix.
Triangulation.		
Coast, Ganjam, Vizagapatam and Godavari	13	i.
Topography.		
Andamans	14	iv
Assam and North-East Frontier	15	v
Baluchistan	17	xiii
Cutch	20	xxiv
South Deccan (Bombay Presidency)	21	...
Gujarat	22	xxiv
Thana and Kolaba districts (Bombay Presidency)	23	xxv
Malwa	24	xxvi
Mirzapur	26	...
Mysore	27	xxxii
Rajputana	28	...
Shwegyin	29	...
Forest.		
Burma Forests	31	xxxii
Cadastral and Traverse.		
Ajmere and Merwara districts	33	...
Akyab	34	...
Bassein and Henzada districts	36	...
Basti	38	xxxiii
Dehra-Dún	41	...
Gorakhpur	42	xxxv
Kamrup	46	...
Punjab Province	48	xliii
Sambalpur (Chhattisgarh division)	50	...
Geographical and Miscellaneous.		
Darjeeling, Nepal boundary, Simla Hill Survey, &c.	53	xliv
Tidal and Levelling Operations.		
Tidal operations	56	...
Spirit-levelling operations in connection with Tidal operations	57	...
Spirit-levelling operations in connection with Revenue Surveys	*ib.*	...
Geodetic.		
Latitude operations	58	...
Tabular Statements.		
1.—Outturn of Field work executed by the Trigonometrical, Topographical, and Revenue Branches	60	...
2.—Table of cost-rates of the Field work of the three Branches	62	...
3.—Abstract of areas and cost-rates according to jurisdictions (Revenue Branch)	63	...
4.—Statements of principal records prepared in the Field party offices (Revenue Branch)	64	...

PART III.

SUMMARY OF THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

	Page Report.	Page Appendix.
1.—Survey of India Offices, Calcutta—		
Surveyor General's Office	65	...
Revenue Survey Branch Office	*ib.*	...
Topographical Survey Branch Office	66	...
Map Record and Issue Office	*ib.*	...
Drawing Office	68	xciv
Engraving Office	70	cv
2.—Photographic Office	71	cix
3.—Lithographic Office	73	cxxvi
4.—Mathematical Instrument Office	74	cxxxi
5.—Trigonometrical Survey Branch Office, Dehra	76	cxxxiv

Appendix.

TABULAR STATEMENTS AND MISCELLANEOUS.

	Page
Extract from the Narrative Report of Coast Party by Mr. A. D'Souza, Assistant Superintendent, 1st grade, in charge, season 1884-85.	i
Extract from the Narrative Report of the Andaman Topographical Party by Captain J. R. Hobday, Officiating Deputy Superintendent, season 1884-85	iv
Extract from the Narrative Report of the Assam and North-Eastern Frontier Survey by Mr. M. J. Ogle, lately officiating in charge, season 1884-85	v
Extract from the Narrative Report of the Assam and North-Eastern Frontier Party by Colonel R. G. Woodthorpe, R.E., season 1884-85	x
Narrative Accounts of explorations from Kumki (on the Diyun river) to Padao (Bor Kampti) of Assam and North-Eastern Frontier Party by Major C. R. MacGregor, season 1884-85	*ib.*
Medical History of expedition to the Singhpo and Kampti-country by Surgeon D. St. J. Grant, I.M.D., attached to Assam and North-Eastern Frontier Party, season 1884-85	xix
Extract from the Narrative Report of the Baluchistan Party by Captain R. A. Wahab, R.E., Officiating Deputy Superintendent, Survey of India, season 1884-85	xxii
Extract from the Narrative Report of the Cutch Topographical Survey by Lieutenant-Colonel A. Pullan, S.C., Deputy Superintendent, Survey of India, season 1884-85	xxiv
Extract from the Narrative Report of the Gujarat Survey Party by Lieutenant-Colonel W. F. Badgley, S.C., season 1884-85	*ib.*
Extract from the Narrative Report of the Konkan Survey by Lieutenant F. B. Longe, R.E., Officiating Deputy Superintendent, Survey of India, season 1884-85	xxv
Extract from the Narrative Report of the Bhopal and Malwa Survey by Mr. W. H. Patterson, Officiating Deputy Superintendent, season 1884-85	xxvi
Notes on the town of Bhinmál and surrounding country by Mr. G. P. Tate, Assistant Surveyor, 2nd grade	xxx
Extract from the Narrative Report of the Mysore Topographical Survey by Major J. R. McCullagh, R.E., Deputy Superintendent, season 1884-85	xxxii
Extract from the Narrative Report of Burma Topographical Survey by Mr. H. Hörst, Deputy Superintendent, Survey of India, season 1884-85	*ib.*
Extract from the Narrative Report of Basti Cadastral Party by Major S. H. Cowan, Deputy Superintendent, season 1884-85	xxxiii
Extract from the Narrative Report of Gorakhpur Cadastral Survey by Major J. E. Sandeman, Deputy Superintendent, Survey of India, season 1884-85	xxxv
Copy of letter No. 518, dated 6th January 1886, from the Settlement Officer, Gorakhpur, to the Deputy Superintendent, in charge Gorakhpur Party	xxxix
Copy of letter No. 10, dated 11th January 1886, from Major J. E. Sandeman, Deputy Superintendent, in charge Gorakhpur Party, to the Deputy Surveyor General, in charge Revenue Surveys	xl

TABULAR STATEMENTS AND MISCELLANEOUS—*continued.*

	Page
Extract from letter No. 540, dated 10th February 1886, from the Settlement Officer, Gorakhpur, to the Commissioner of Benares Division	xli
Extract from the Narrative Report of Punjab Party by Lieutenant-Colonel F. Coddington, Deputy Superintendent, season 1884-85	xliii
Extract from the Narrative Report of Himalaya Party by Colonel H. C. B. Tanner, Deputy Superintendent, season 1884-85	xliv
Original Narrative Account by R— N— of his exploration of the country to the North and North-West of Kinchinjanga made in the autumn of 1884, with notes by Colonel H. C. B. Tanner, Deputy Superintendent, and Mr. W. Robert, Surveyor, Survey of India	xlviii
Extract from the Narrative Report of Tidal and Levelling operations by Major A. W. Baird, R.E., F.R.S., Deputy Superintendent, Survey of India, season 1884-85	lii
Extract from the Narrative Report of Astronomical Parties Nos. 1 and 2, season 1884-85	xc
Report on the Geographical position of Mashhad by Major T. H. Holdich, R.E., Deputy Superintendent, in command of detachment, Survey of India, with the Afghan Boundary Commission, dated 12th August 1885	xcii
Drawing Office, Section I	xciv
" " " II	xcix
State of Publication of Cadastral Maps	civ
Engraving Office	cv
Photographic Office	cix
Lithographic Office	cxxvi
Mathematical Instrument Office	cxxxi
Trigonometrical Branch Office	cxxxiv

LIST OF MAPS.

	Page Report.
Index showing progress of Imperial Surveys	Frontispiece.
Triangulation.	
Index chart of Triangulation of the Great Trigonometrical Survey of India	*ib.*
Topographical.	
Index to the sheet maps of the Trans-Frontier Survey	9
Index to the sheets of the Andaman Survey	14
Index to the sheets of the Assam and North-Eastern Frontier Survey	15
Index to the sheets of the Baluchistan Survey	17
Index to the sheet maps of the Cutch Survey	20
Index to the sheet maps of the Deccan and Konkan Survey	21
Index to the sheet maps of the Gujarat Survey	22
Index to the sheet maps of the Malwa Survey	24
Index to the sheet maps of the Mirzapur Survey	26
Index to the sheet maps of the Mysore Survey	27
Index to the sheet maps of the Rajputana Survey	28
Index to the sheet maps of the Shwegyin District Survey	29
Forest.	
Index to the sheets of the Burma Forests Survey	31
Cadastral and Traverse.	
Index to the sheets of the Ajmere and Merwara districts Survey	33
Index to the sheets of the Akyab district Survey	34
Index to the sheets of the Bassein and Henzada districts Survey	36
Index to the sheets of the Basti district Survey	38
Index to the sheets of the Dehra-Dún district Survey	41
Index to the sheets of the Gorakhpur district Survey	42
Index to the sheets of the Kamrup district Survey	46
Index to the sheets of the Punjab Survey	*ib.*
Index to the sheets of the Sambalpur (Chhattisgarh division) district Survey	49
Geographical and Miscellaneous.	
Index to the Indian Atlas, showing sheets published up to October 1885	68
Index to the Indian Atlas, showing the state of the engraving up to October 1885	70

Errata to Annual Report for 1883-84.

PAGE.			
xxviii.	Line 59,	for "Khâm"	read "Bhâm".
„	Last line,	for "Depicted"	„ "Deposited".
xxix.	Line 29,	for "Eincha-La"	„ "Eucha-La".
xxx.	Line 61,	for "Section 13"	„ "Se 13".
xxxiii.	Line 20,	for "Purnean"	„ "Purneah".
xxxiv.	Last column of table strike out "with Biddulph".		
xliv.	Last line but one, for "Kar-ma-sing" read "Kar-ma-ling".		
xlviii.	Line 4,	for "Barojil"	read "Barogil".
„	Line 7,	for "Tshkarmam"	„ "Ishkaman".
„	Line 13,	for "Barojil"	„ "Barogil".

Erratum to Annual Report for 1884-85.

In page 40, para. 190, *first* line, *for* "page xxxix of the appendix" *read* "page 62, Part II."

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1884-85.

PART I.

INTRODUCTORY.

The period to which the General Report of the Survey of India refers, on its annual issue and submission to the Government of India in the Revenue and Agricultural Department, commences on the 1st of October of each year, and covers the twelve months following. Field operations usually commence in October and are carried on during the cold season generally for six months. During the hot weather and rains the mapping, calculations, and general records connected with the operations of the previous field season are completed. The "survey year," as it is termed, thus embraces a complete round of survey operations from the commencement of the field work to the completion and submission of the maps and records connected therewith.

2. The direction of the Survey of India during the year 1884-85 remained without interruption in the hands of Colonel G. C. DePrée, B.S.C., the Surveyor General of India. He, at the same time, held the *ex-officio* post of the Deputy Surveyor General in charge of the Topographical Branch, and superintended the field and recess proceedings of the eight field parties classed under that branch.

3. The superintendence of the Revenue Branch was carried on without intermission during the 12 months by Lieutenant-Colonel H. R. Thuillier, R.E., Deputy Surveyor General. This charge included five field parties engaged in Cadastral Surveys in Burma, Assam, and the North-Western Provinces, two Topographical parties in the Bombay Presidency and one in British Burma, together with two Traverse parties and three detachments working in various localities. An unusual degree of responsibility attached to this charge, owing to the transfer of Field parties from Burma to the Central Provinces and Bengal, and connected with the initiatory measures required for the introduction of Cadastral Surveys into Bengal as well as in other localities.

4. The Trigonometrical Branch has been efficiently superintended during the same period by Colonel C. T. Haig, R.E., Officiating Deputy Surveyor General. He personally supervised the large office at Dehra, containing small but efficient sections for map compiling, photozincography, and the printing of the scientific volumes, as well as two observatories fitted up with photo-heliographic instruments rendering sun pictures of 8 and 12 inches diameter. In addition, he superintended the work of four field parties engaged on special and scientific operations, of three Topographical parties, and of the Computing Office, which has now been constituted a separate executive charge under Mr. W. H. Cole, M.A. His duties have proved more than ordinarily exacting and responsible.

5. The Technical offices located in Calcutta have been fortunate in retaining the services of the three experienced and zealous Assistant Surveyors General, *viz.*, Major C. Strahan, R.E., in charge of the Drawing, Compiling and Engraving Sections, Lieutenant-Colonel J. Waterhouse, S.C., in charge of the Photozincographic and Lithographic Office establishments, and Major M. W.

Rogers, R.E., who has introduced improvements into the already efficient Mathematical Instrument Office, and has administered the Correspondence and Accounts Sections of the Surveyor General's Office. Lieutenant-Colonel W. H. Wilkins, S.C., had charge of the Map Record and Issue Office, and under his superintendence the immense store of maps has been carefully catalogued and systematically arranged. It is to be regretted that this condition of superintendence cannot obtain for a longer period: the three Assistant Surveyors General are about to proceed on furlough, two of them having entirely broken down in health. It may here be noted that Colonel DePrée will be compelled, owing to the same cause, to seek rest and relaxation, and to apply for furlough.

6. During the year the Surveyor General has carried out numerous inspections of offices and of field parties in various parts of India during his journeys between Calcutta and Simla. These comprised the careful examination of all the sections of the Great Trigonometrical Office at Dehra and Mussooree, and of the Survey Branch of the Forest Department established at Dehra. Subsequently Poona was visited, and four field parties and several of the Tidal observatories erected in the harbours of the western coast were inspected. In April 1885, the Jeypore City Survey party was a second time looked at.

The Deputy Surveyor General, in charge Revenue Branch, was unable to leave Calcutta to carry out his usual inspections owing to press of work and the paucity of officers available for duty at the Head-quarters' Offices.

The Deputy Surveyor General in charge of the Trigonometrical Branch visited his field parties at Poona.

One of the administrative officers in Calcutta, Lieutenant-Colonel J. Waterhouse, made a tour in the North-Western Provinces, during which he took part in a Committee on the working of the Great Photo-heliograph at Dehra. He also inspected the maps of several field parties and drew up a report on the style of drawing best adapted for successful photographic reproduction. By such inspections and intercourse the tendency of field parties to adopt each its own sort of drawing is counteracted and uniformity of system is more easily effected.

7. During the year under review the Department has sustained the loss, by retirement from the service, of two officers, who, during the past quarter century, have contributed largely to the operations of the Trigonometrical Survey.

Colonel B. R. Branfill, of the Bengal Cavalry, retired on the 10th November 1884 after a service of 30 years, of which 26 were in the Survey Department. During this period he superintended the great spirit levelling operations extending from Kurrachee to Upper India. He conducted the operations of the Great Triangulation over the most part of Southern India; and carried a series of triangles over Adam's Bridge connecting the Indian with the Ceylon Triangulation. Finally, he closed an honourable career in the Department in superintending the measurement of the Base line at Mergui.

Colonel W. M. Campbell, R.E., retired from the service on the 28th November 1884 after more than 26 years' service, of which nearly 22 were passed in the Survey Department. Colonel Campbell was engaged in various operations from time to time, but his great service to the Department was in the astronomical operations extending from 1863 to the time of his finally quitting the country in 1883. He established the connection between Greenwich Observatory and the Indian Triangulation *viâ* Suez and Aden by the determination of longitudes by means of transit instruments in conjunction with the Electric Telegraph. From March to November 1879, he superintended Survey operations in Southern Afghanistan, in conjunction with the column under Sir Donald Stewart, for which service he received a medal and Brevet Lieutenant-Colonelcy.

In October 1885, two more officers of the Senior Division quitted the Department, *viz.*, Messrs. H. B. Talbot and J. McGill, Deputy Superintendents, 4th grade, who have both come under the operation of the superannuation rule. The former officer had served in the Trigonometrical and Revenue Branches for nearly 37 years, and the latter almost exclusively in the Trigonometrical Branch for 34 years. Both have rendered approved service, and have held executive charge of field parties.

Major Baird, Deputy Superintendent, has been temporarily removed from the Department, and appointed Officiating Master of Her Majesty's Mint at Calcutta.

Lieutenant-Colonel Herschel has been again retained on duty in England throughout the year: he is neither under the control of, nor in official correspondence with, the Surveyor General. Thus, while his services are not available for the general purposes of the Survey of India, now so hard pressed to find officers for the numerous duties it has been called upon to carry out, no other officer has been appointed in his room and his name is still retained on the effective list.

8. During the year under review, five additions have been made to the 2nd grade of Assistant Superintendents, *viz.*, Lieutenants S. G. Burrard, R.E., and J. M. Fleming, S.C., Mr. J. Eccles, M.A., of Cambridge,—a specialist selected by Her Majesty's Secretary of State,—and two Surveyors promoted from the Junior Division, Messrs. A. D'Souza and G. B. Scott. The strength of the Senior Division remained at 52 officers.

In the Junior Division two members have left the Department, one having been transferred and the other having resigned. Four new appointments have been made. The net result is that 133 Surveyors and Assistant Surveyors remained on the roll at the end of the year.

9. As mentioned in the last report at paragraph 47, the Survey of India has continued to work to the utmost limit of its capacity. The returns of the various Technical offices show how large has been the out-turn of copies of maps printed and issued, and of instruments repaired and returned to the various Departments of the several provinces. It may not be regarded as out of place here to enumerate the names and nature of the various offices which, while superintended directly by their respective Administrative Officers, are under the control and direction of the Surveyor General. They are as follow:—

Statement of Administrative and Technical Offices of the Survey of India Department.

Names of Offices and Sections.	Page in this Report.	Nature of Current Operations.	Administrative Superintendent.
HEAD-QUARTERS, CALCUTTA.			
Administrative.			
Surveyor General's	65	Accounts, Correspondence	A. S. G., S. G. O.
Deputy Surveyor General's, Revenue Branch	*ib*	Ditto	D. S. G., Rev.
Deputy Surveyor General's, Topographical Branch	*ib*	Ditto	D. S. G., Topo.
Map Record and Issue	66	Correspondence, Receipts and Issues	D. D. Officer.
Technical.			
Drawing and Compiling	68	Mapping	A. S. G., D. O.
Engraving	70	On copper by hand	Do., Do.
Photozincographic	71	Mapping, Litho. and Type Printing	Do., Litho.
Lithographic and Printing	73	Repairing, Storing and Issue	Do., M. I. O.
Mathematical Instrument	74	Photo. Reproduction and Zinc Printing	Do., Photo.
TRIGONOMETRICAL BRANCH, DEHRA-DÚN.			
Administrative.			
Deputy Surveyor General's, Trigonometrical Branch	76	Accounts, Correspondence	D. S. G., Trig.
Technical Sections.			
Drawing and Compiling	76	Mapping	Do.
Meteorology	78		Do.
Photozincography	*ib*	Photo. Reproduction and Zinc Printing	Do.
Printing	77	Letter-press Printing	Do.
Photo-heliography	78	Solar Photography	Do.

10. The field operations prosecuted during the year are shown in the following tabular statement. To them must be added the Computing Office which never takes the field but alternates between Dehra and Mussooree.

Statement of Survey Operations and Field Parties.

Name and *locale* of operations.	Page in this report.	Executive Officers.	Designation of Survey Party.	Scale of Survey.	Administrative Superintendent.
Triangulation.					
Coast (Madras)	13	Mr. A. D'Souza	Secondary Triangulation.	.....	D. S. G. Trig.
Topography.					
Andaman Islands	14	Captain J. R. Hobday, S.C.	No. 4, Topo. Branch	4″ and 1½″=1 mile for reproduction.	Ditto Topo.
Assam and North-Eastern Frontier.	15	Lieutenant-Colonel R. G. Woodthorpe, R.E.	No. 6, ditto.	1″ and ½″=1 mile for reproduction.	Ditto ditto.
Baluchistan	17	Captain R. A. Wahab, R.E.	No. 3, ditto.	1″=1 mile for reproduction.	Ditto ditto.
Cutch	20	Lieutenant-Colonel A. Pullan, S.C.	Cutch Survey	2″=1 mile for reproduction and reduction, and 1″=1 mile.	Ditto ditto.
Deccan	21	Major D. C. Andrew, S.C.	No. 11, Rev. Branch	2″=1 mile for reduction to 1″ scale.	Ditto Rev.
Gujarát	22	Lieutenant-Colonel W. F. Badgley, S.C.	Gujarát Survey	4″ and 2″=1 mile for reproduction and reduction to 1″ scale.	Ditto Topo.
Himalaya (Simla Hill States)	...	Colonel H. C. B. Tanner, S.C.	Darjeeling	4″=1 mile	Ditto Trig.
Konkan (Kolába)	23	Major J. Hill, R.E.	No. 10, Rev. Branch	2″=1 mile for reduction to 1″ scale.	Ditto Rev.
Malwa	24	Mr. W. H. Patterson	No. 2, Topo. Branch	1″=1 mile for reproduction.	Ditto Topo.
Mirzapur	26	Lieutenant-Colonel J. R. Wilmer, S.C.	No. 5, ditto	2″=1 mile for reproduction and reduction to 1″ scale.	Ditto Trig.
Mysore	27	Major J. R. McCullagh, R.E.	No. 6, ditto	1″=1 mile for reproduction.	Ditto Topo.
Rajputana	28	Major R. Beavan, S.C.	No. 1, ditto	1″=1 mile for reproduction.	Ditto Trig.
Shwegyin	29	Mr. E. J. Jackson	No. 2, Rev. Branch	2″=1 mile for reproduction, and reduction to 1″ scale.	Ditto Rev.
Forest Surveys.					
Burma	31	Mr. H. Hörst	No. 7, Topo. Branch	4″=1 mile for reproduction.	Ditto Topo.
Konkan (Thána)	23	Major J. Hill, R.E.	No. 10, Rev. Branch	4″=1 mile for reproduction, and 2″=1 mile for reduction to 1″ scale.	Ditto Rev.
Cadastral Surveys.					
Akyab	34	Mr. H. B. Talbot	No. 7, ditto	16″=1 mile for reproduction, and 2″=1 mile for reduction to 1″ scale.	Ditto Rev.
Basti	38	Major S. H. Cowan, S.C.	No. 4, ditto	Ditto ditto	Ditto ditto.
Dehra Dún	41	Mr. W. A. Wilson	Detachment	16″=1 mile for reproduction.	Ditto ditto.
Gorakhpur	42	Major J. E. Sandeman, S.C.	No. 5, Rev. Branch	16″=1 mile for reproduction, and 2″=1 mile for reduction to 1″ scale.	Ditto ditto.
Henzada and Bassein	36	Major H. S. Hutchinson, S.C.	No. 8, ditto	Ditto ditto	Ditto ditto.
Kámrup	45	Mr. E. C. Barrett	No. 6, ditto	Ditto ditto	Ditto ditto.
Traverse Surveys.					
Ajmere and Merwara	33	Major E. H. Steel, S.C.	No. 3, ditto	16″=1 mile.	Ditto ditto.
Panjab	46	Lieutenant-Colonel F. Coddington, S.C.	No. 1, ditto	16″=1 mile, and 2″ compilation for reduction to 1″ scale.	Ditto ditto.
Sambalpur	50	Mr. P. A. G. Cowley	Detachment	16″=1 mile.	Ditto ditto.
Geographical and Miscellaneous.					
Darjeeling (Nepal Boundary).	53	Colonel H. C. B. Tanner, S.C.	Darjeeling	4″ and 1″=mile for reproduction.	Ditto Trig.
Singpho Hills	...	Lieutenant-Colonel R. G. Woodthorpe, R.E.	No. 6, Topo. Branch	1″ and ½″= 1 mile. Reconnaissance for reproduction.	Ditto Topo.
Tidal and Levelling Operations.					
Tidal operations Spirit-levelling	54	Major A. W. Baird, R.E.	Tidal and Levelling	.....	Ditto Trig.
Geodetic.					
Latitude operations	57	Major W. J. Heaviside, R.E.	Nos. 1 and 2, Astronomical Parties.	.....	Ditto ditto.

TRIANGULATION.

11. The last statement shows that only one small party was employed on secondary triangulation about the coast line between Berhampore and the Godávari river. A secondary series to connect Burma with the Straits of Malacca is a work to be undertaken at some future, but unnamed date.

SPECIAL OPERATIONS.

12. Owing to the Transit Instrument being under repairs in England, the Electro-Telegraphic Longitude operations have been temporarily suspended. One Astronomical party was therefore engaged in taking observations for direct latitudes at eight stations of the Amúa Series of the Great Trigonometrical Survey. The Tidal operations were steadily prosecuted: two new observatories were established, one at Cochin, another at Cocanada; and two were closed, one at Beypore and another at Vizagapatam: thus retaining the original number of 19 automatically recording stations. Subsequently, however, the observatory at False Point was swept away in the Cyclone of 22nd September, after having registered the tidal flow for 4½ years out of the five theoretically required to complete the full record.

TOPOGRAPHY.

13. As the interior of India has for the most part come under preliminary topographical survey, the sphere of these operations is being gradually contracted. The regular topographical operations have been carried on in continuation of those of the preceding year, in the same districts and by the same parties, except in the Aligarh district of the North-Western Provinces, where the topographical survey has been suspended and the party removed for Revenue work. On the other hand, the Shwegyin party in British Burma has been released from cadastral operations and was employed on topographical work in that district pending a demand for Cadastral Surveys elsewhere. During the year under review, two Topographical Survey Parties have finished the work assigned to them, *viz.*, those working in the Malwa district and on the North-East Frontier. The former party has been diverted to Revenue operations elsewhere and the latter party has been broken up. During the ensuing year three other parties will complete operations in Cutch, in the Andaman Islands, and in Mysore.

New ground has been assigned to the late Darjeeling Party in the unsurveyed regions in the hills of Kángra and adjacent Native Hill States of the Punjab. It is in contemplation to employ this Himalaya Party as a training school for military officers, with a view to fit them for accurate reconnaissance, and for effecting reliable surveys independently, or when acting with an army in the field. Again Upper and Lower Burma seem to afford practically an unlimited field for future surveys. This country must always be an extremely difficult one for the progress of survey operations, owing to its intricate and forest-clad hills. Meanwhile, a glance at the Map of India forming the frontispiece of this report, will show how small an area has been surveyed and mapped even in the province which has been in the possession of the British Government for more than three decades. The only other regular Topographical Surveys that demand any particular comment are those of the Andamans and of Baluchistan. Special measures had to be initiated for carrying out the triangulation of the numerous scattered islands forming the Andaman group; and great difficulty was experienced in delineating the topography of these inhospitable islands with their creek indented shores and interior ridges of forest-clad hills. The survey in Baluchistan was of an equally trying nature; the sparseness of the population, the difficulty in procuring water and the necessaries of life, and the generally inhospitable nature of this rocky and desert region, all combined to make the progress of the survey a work of much toil and discomfort.

The general result of the Topographical operations executed during the year, excluding Forest surveys, is an out-turn of 26,413 square miles—

1,450	Square miles surveyed on the	¼	inch scale.
9,089	„ „	½	„
5,395	„ „	1	„
8,416	„ „	2	„
191	„ „	4	„
1,725	„ of reconnaissance on ¼ and ⅛ inch scales.		
147	„ of towns and cities on scales, 6″, 12″ and 16″.		

RIVERAIN AND FOREST SURVEYS.

14. The Riverain surveys, on the 4 inch scale, along the Gogra river, have been continued in connection with the cadastral operations in the districts of Gorakhpur and Basti. The alluvial lands in districts Ballia and Azamgarh lying opposite to Gorakhpur, have thus been completed, and those in district Fyzabad will be finished during the current season.

15. The survey of the Forests, on the scale of 4 inches to the mile, in the Thána district, undertaken for the Forest Department, has been completed by the party working in the Konkan.

In British Burma the survey on the 4 inch scale of the reserved Forests on the Pegu-Yoma range has been continued on both the eastern and western slopes thereof under similar physical difficulties and under the same modified system, whereby a considerable amount of the minor detail is shown in an approximate manner only, as explained in the previous reports of the Burma Topographical Party. The out-turn this year shows a considerable increase over that of the two former seasons.

16. The areas of these operations are as follow :—

	Square miles.
Riverain	162
Forest	942

CADASTRAL AND TRAVERSE SURVEYS.

17. Six full parties and two detachments had been employed during the preceding year on Cadastral Surveys; of these, the Pegu party in British Burma was relinquished by the Local Government owing to financial difficulties and diverted to topographical operations, and the operations of the Chhattisgarh detachment were confined to skeleton traverse survey. Thus five parties and one detachment have been employed during the year under report on Cadastral Surveys, *viz.*, two parties and one detachment in the North-Western Provinces, two parties in British Burma and one party in Assam, and they have all continued their operations in the same districts as during the previous year. Of these several operations, the surveys of the Dehra-Dún district in the North-Western Provinces and of the Henzada district in British Burma have been completed.

18. In the North-Western Provinces, the Gorakhpur and Basti parties have, as before, continued the preparation of the Record-of-Rights concurrently with the survey. The Gorakhpur system, which was described in paragraph 21 of the last Annual Report, was carried out in both districts, and further improvements in the results have been developed. Alterations in the division of labour between the Survey and Settlement Departments have been introduced, whereby the duties and responsibilities of the Survey Department have been increased, but no additional cost has been incurred. The details of the operations of these parties as well as the cost thereof are given at pages 60—63 of this Report. It will be noticed that the cost of the Survey Department has been still further reduced. The cost rate of all the operations undertaken in the Gorakhpur Survey Party is 4⅛ annas per acre against 4½ annas in the preceding year. For the first time, the separate charges for each description of work have been obtained, and the results give ample evidence of the economy of the system as far as the Survey Department is concerned. Thus the cost rate of the field survey, including permanent marks, traversing, and preparation of the village maps for reproduction is ₹92-15 per square mile, and that of the complete records ready for attestation and assessment is ₹78-3.

Every effort has been made by the Survey Department to reduce the cost of its operations to the lowest possible limit consistent with accuracy, and this limit has now been attained; it must be remembered that for this expenditure there is a professional guarantee for the accuracy of the records, as well as for the survey.

19. The extent to which it will be possible to reduce the total cost of the settlement on this new system, now depends on the expenditure of the Settlement Department, whose work consists of—

(1) demarcation of boundaries;
(2) attestation;
(3) assessment;
(4) fairing of the records.

A statement of the cost incurred in one *tahsil* for the above operations has been received from the Settlement Officer of Gorakhpur, and the cost rate amounts to ₹239 per square mile. The cost rate for the operations by the Survey Department over the same area is ₹171 per square mile; thus the "total" cost amounts to ₹410 per square mile.

20. The cost of the work by the Settlement Department is undoubtedly very heavy, but explanations are given which will be found in the appendix to this report, pages xl, showing that there are many local causes which have tended to raise the cost so far, *viz.*, the prevalence of complicated tenures, minute holdings and disputes due to inaccurate maps; but it is also evident that much use has not been made of the district agency, and that most of the operations have been effected by special establishments. Under such circumstances, a fair comparison cannot yet be made between the cost of the North-Western Province system and those of other provinces. Nor even can the cost of the same system be fairly contrasted in different provinces, owing to the local variations of tenures, rights of occupancy, size of holdings, cost of labour, &c. This is clearly proved by the results of the Cadastral Survey of the Kámrúp district in Assam, where a similar system of survey and settlement is being carried out as in Gorakhpur. Here the cost of the Survey Department is larger, but the expenditure of the Settlement Department is so very much less than in Gorakhpur, that the "total" cost per square mile of the operations in Assam is only ₹270, or ₹141 per square mile less than in Gorakhpur. The following table gives the figures for each province:—

District and Province.	Cost rate of operations by Survey Department.	Cost rate of operations by Settlement Department.	Total cost rate.
	Per square mile.	Per square mile.	Per square mile.
	₹	₹	₹
Gorakhpur, North-Western Provinces . .	171	239	410
Kámrúp, Assam	221	49	270

It will therefore be acknowledged that it is not due to the employment of the Survey Department, that the cost of the complete operations in Gorakhpur has been so high.

The district staff should undoubtedly be used to the utmost extent for the sake of economy; but whether it would be economical or advisable to employ it on the field survey still remains an open question, for there are other ways in which the patwaris could be utilized to reduce the cost, such as in the work preliminary to survey, the preliminary attestation and the fairing of the records. The Survey Department is, however, quite willing to try the experiment, but it maintains that the employment of such men on the field survey without professional supervision, will impair the accuracy of the map. The cost rates obtained by the Survey party in Gorakhpur will, it is believed, bear favourable comparison with any work done by any other agency or supervision.

21. Sufficient progress has not yet been made in the system adopted in the Central Provinces, wherein the Survey Department furnishes a skeleton frame-

work only and the survey of the fields and preparation of the records is left to the patwaris under the superintendence of a Settlement Officer, to obtain a statement of the cost of the complete operations.

22. The result of the survey operations in the Punjab shows that the patwari maps can be utilized for the construction of topographical maps on a small scale, when fixed points are established by professional traversing. Experience has shown that the extent of fixed points, which is necessary to fit the village maps together, must comprise all the village trijunctions, and this is the extent of the professional traversing that has been carried out in the districts operated in, which had previously been surveyed by the Settlement Department. The Punjab Government has restricted this basis to the same extent for other districts, in which the patwari survey is to follow; so that although it will be useful to the Survey Department for compiling new topographical maps, this limited framework cannot be considered sufficient to ensure the accuracy of the field plotting, except in the cases when the villages are very small and in which the trijunctions are at close intervals. The cost rate of the traversing, reducing the maps, testing the details and preparing revised topographical maps, has amounted to ₹22-3 per square mile; in this the largest rate for traversing is taken, as the more extended work will be continued in future. The only information that has been obtained of the cost of survey and settlement done by the Settlement Department in the Punjab is that of the Ludhiána district, which is taken from the Settlement Report of that district. The total cost of the settlement is given at ₹4,94,268 for an area of 1,378 square miles, this gives an average mileage rate of ₹358-10, but of this cost, the sum of ₹1,38,129 has been deducted on account of fees, &c., credited to Government, thus leaving the net cost of settlement ₹3,56,139 or ₹258-7 per square mile: if to this expenditure is added the cost of the Professional Survey Department, the total cost rate under the present procedure will be about ₹280 per square mile.

23. The skeleton traverse survey of the *khalsa* villages in Ajmere-Merwara has been completed by the No. 3 party which had been withdrawn from the topographical operations in Aligarh. After the party had left the district, a demand was made for an extension of the survey, to the *jagir* villages; this could well have been done by the party during the year under report concurrently with the *khalsa* villages, had orders been received in time. A detachment has now to return to Ajmere to carry out this work.

24. The detachment which had been employed in experimental operations in Raipur district, Central Provinces, was transferred to the Sambalpur district and has been engaged on a skeleton survey on the field block system in accordance with the views of the Local Government. It has now been decided to abandon the survey of the boundaries which this system entailed and to restrict the professional framework to traversed points only.

The areas surveyed cadastrally are—

	Square miles.
North-Western Provinces	1,534
British Burma	1,189
Assam	478

The areas of the traverse surveys are—

	Square miles.
Punjab	7,251
Rajputana	1,000
Central Provinces	499

GEOGRAPHICAL EXPLORATION.

25. Great additions have been made to our geographical knowledge of trans-frontier countries. Attention is naturally first attracted to the admirable contributions to our knowledge of the country on the west of Baluchistan, made by Survey officers attached to the Afghan Boundary Commission. An independent traverse has been made all the way from Quetta to Kuhsan, distance about 767 linear miles, without a break. Between Nushki and Khwaja Ali, the country was triangulated and a topographical survey was carried on along two separate routes, embracing an approximate area of 6,000 square miles. The Halmand valley was mapped up to the Hamun. From Khwaja Ali to Jawani

Survey of India Department.

INDEX TO THE TRANS-FRONTIER OF INDIA SHEETS.

On the Scales of 1 Inch = 16 Miles, 8 Miles, 4 Miles, and 2 Miles.

NORTH-WESTERN TRANS-FRONTIER
NORTHERN TRANS FRONTIER
NORTH-EASTERN TRANS-FRONTIER
SOUTH-EASTERN TRANS-FRONTIER
ARABIAN SEA
BAY OF BENGAL
NOTES.
Sheets on the Scale of 1 Inch = 8 Miles are numbered No. 1, No. 2, &c.
A Sheet on the Scale of 1 Inch = 16 Miles will consist of 4 of the Sheets shown on the Index, and will be entitled Sheet No. 1, 2, 3, and 10.
A Sheet on the Scale of 1 Inch = 4 Miles will consist of a one-fourth part of a sheet shown on the Index, and will be entitled Sheet No. 4 N.W., No. 2 S.E., &c. (Vide Diagram).
A Sheet on the Scale of 1 Inch = 2 Miles will consist of a one-sixteenth part of an eight-mile sheet shown on the Index, and one-fourth part of a quarter-inch sheet, and will be entitled Sheet No. 2 N.W., No. 2 S.E., &c. (Vide Diagram.)

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Photolithographed at the Survey of India Offices, Calcutta.

the topography was necessarily confined to the route, as nothing was visible for any distance on either side. From Jawani northwards, triangulation and topography were re-commenced, the country again being hilly. The plane-tabling in this portion of the route covers an area of about 9,000 square miles. The total area plane-tabled along the route amounts to 15,000 square miles. Major Holdich and his assistants, Captains St. G. Gore and the Hon'ble M. G. Talbot, all of the Royal Engineers, deserve every credit for the admirable way in which they have utilised their opportunities during their deputation with the Commission. They are still engaged in surveys connected with the work of the mission on the Afghan Frontier. Major Holdich's report on these operations will be published in a separate volume by order of the Government of India. On the North-East Frontier, Colonel Woodthorpe, R.E., started from the head of the Assam valley, crossed the watershed of the Patkai range, and descending into the valley of the Western Branch of the Irrawaddy, communicated with the friendly Bor Kamtis in their own villages. After encountering much hardship, this officer, accompanied throughout by Major C. R. MacGregor, B.S.C., effected a return to his advanced depôt of supplies, and then at once recrossed the Patkai range, and proceeding in a southerly direction, and then changing his course generally westwards fell in with the Nongyong lake. Thence the small and nearly worn-out band, following the route discovered by Wilcox in 1828, re-entered Assam. No sooner had Colonel Woodthorpe and his comrades turned their steps homewards, than a fresh demand was made for the services of this intrepid officer to accompany the mission to Gilgit. He responded to the call without hesitation and is still engaged in that distant locality.

26. The result of the advance with the Zhob valley field force has already been given in paragraph 34 of the report for 1883-84. The triangulation brought up from Baluchistan was connected with the rapidly-executed work about the Takht-i-Suliman of the preceding year.

27. The expedition to Suakim afforded another opportunity for an officer of this Department to operate with an army in the field. By order of Her Majesty's Secretary of State, a small detachment was fitted out and placed under the charge of Lieutenant F. B. Longe, R.E., who proceeded to Suakim and executed certain surveys in the neighbourhood, which elicited a favourable report from the General Commanding. The good service performed by this young officer has been duly acknowledged by the Government of India.

28. Our knowledge of the hitherto scaled region north of Kinchinjanga has been considerably extended this year by the explorations of Sub-surveyor R—N, who made a circuit round that great mountain. He has delineated the boundary between North-East Nepal and Tibet, fixed the peak of Nuijin Sangra and completed the sketch of the Zemu river as well. His own account of his travels will be found at page xlviii of the appendix, and also a short notice at page 55, Part II of this report.

THE INDEX OF TRANS-FRONTIER SERIES OF MAPS AND THE MILITARY MAP OF INDIA.

29. It has been always a subject of regret that, when geographical information of unknown territory has been collected by surveyors, explorers, or travellers and added to our stock of knowledge, the maps or sketches have been published in a fragmentary and disconnected form. A scheme has, therefore, been drawn out with the object of counteracting this condition of affairs and of combining materials, however heterogeneous, in uniform style, and in sheets of uniform size. This has been effected by regarding all countries outside India as trans-frontier, and preparing index maps, so as to cover all south of the parallel of 40° north latitude and between the meridians of 56° and 104° east longitude. These maps have been divided into four great parts, conforming to the north-western, the northern, the north-eastern, and south-eastern trans-frontier regions. These are sub-divided into sheets of uniform size, following the method already established in the case of the standard maps inside India. Thus, any piece of new survey, however disconnected it may be, can be inserted in its appropriate place in one sheet or other. These sheets, enclosed as they are by lines of latitude and longitude, cannot be joined together in large numbers so as to form one complete map; but the facility with which they are projected is

very great, and the above objection is not of vital importance for a preliminary issue.

The same system has been applied to the more distant countries of Western Persia, Arabia, and Turkey in Asia, and an index map has been prepared accordingly to suit the series of sheets to be entitled South-Western Asia. To allow of the preparation of this great work, the Secretary of State has transferred to the Survey of India a large stock of materials from England. Contributions are received and incorporated when collected by the Military or Foreign Departments.

A third map of importance has also been undertaken in the form of a Military and Railway Map of India. It was originally intended to prepare it on the scale of 1″=16 miles, but the time that its preparation would have taken on so large a scale precluded its being undertaken. It is now being drawn on stone on half that scale in four different colours.

HONOURS AND REWARDS.

30. The Royal favour has been extended to John B. N. Hennessey, Esq., M.A., F.R.S., late Deputy Surveyor General in charge of the Trigonometrical Branch, and he has been appointed to be a Companion of the Order of the Indian Empire. This recognition of long and honourable service is a matter of interest to the members of the Department.

At paragraph 31 of the Report of 1883-84, the exploration of Mr. McNair in Chitral was adverted to; since then "The Saiyed" and "Meah," companions of that Surveyor, have been rewarded by grants of money. The explorer A—K has received the donation of a sum of money, together with a gold watch, from the Royal Geographical Society, he having previously received the title of *Rai Bahadur* and a rent-free village from the Government of India, in recognition of his expedition into Mongolia.

GENERAL REMARKS.

31. It should be here recorded that the most pressing difficulty exists at this time in providing officers to superintend the various field operations in India, and beyond the frontier, owing to the paucity of their number. The demands for extra surveys, to meet the wishes of the Military and Foreign Departments, have been very great. Yet further demands are expected for surveys in Upper and Lower Burma. At this time no reserve of officers exists, and the charge of field parties is devolving on officers of junior, or subordinate, grades, who, though they may serve a temporary emergency, are not qualified to permanently superintend such responsible operations. This undesirable and injurious state of affairs has been brought about by the withdrawal of many officers, without filling up the vacancies so created. No less than six officers of ripe experience have been thus withdrawn. One has been employed in England on pendulum reductions for many years, which still further limits the number available for such duties; three officers are still with the Afghan Boundary Commission; a fifth with the Gilgit Mission; and the sixth has lately been withdrawn to fill the Mint Mastership at Calcutta. The result is, that no officers, except those still in training, are available to meet any further demand. Every qualified officer is already in charge of some work. At the same time the officers, who are administering the three branches and the various technical offices, are overwhelmed with work. Generally speaking, the reports of the several field parties prove that every nerve is being strained to produce a full tale of work, and the technical offices have at the same time largely exceeded their usual out-turn of maps and instruments.

32. It remains only to touch upon the various innovations introduced during the year under review, as well as upon the special objects completed or undertaken.

A pamphlet containing a set of cartographic scales, comparing the Russian versts with the English miles, and French metres, to which has been added the Russian alphabet and its equivalents in English, also weights, coinage, and other particulars useful to a person dealing with Russian geography, has been published. A second pamphlet, referring to the Pushto language, containing a vocabulary adapted for explorers or officers surveying in, or travers-

ing Afghanistan, has also been compiled, and will shortly be published. It is in contemplation to issue a series of such manuals for the use of explorers in other trans-frontier regions.

A steam type-printing machine has been acquired, and placed temporarily in the Mathematical Instrument Office so as to take advantage of the steam power there.

A circular dividing machine has been obtained by purchase from the Madras Government; it has been set up and is now doing most effective work. Large numbers of unserviceable theodolites have been repaired and re-divided by this machine, thus many instruments, which were previously unsaleable and almost valueless, have been made serviceable and large sums have been saved thereby.

33. The monthly publication entitled the "Notes of the Survey of India Department" has been regularly issued since January 1884. It has therefore now existed for more than two years, and is appreciated by the surveyors who are scattered over distant and often almost inaccessible parts of the country.

PART II.

THE OPERATIONS OF THE SEVERAL SURVEY PARTIES APPERTAINING TO THE THREE BRANCHES OF THE SURVEY OF INDIA.

TRIANGULATION.

COAST, GANJAM, VIZAGAPATAM AND GODÁVARI.

(THE COAST SURVEY PARTY.)

Personnel.

Mr. A. D'Souza, Assistant Superintendent, 2nd grade.
Mr. C. D. Potter, Surveyor, 4th grade.

In continuation of the work done during the two previous seasons on the eastern coast of India, this party resumed field operations in November last at Kovita (near Berhampore), the terminal station of the series executed by Mr. J. McGill in 1882-83, and carried on the construction of beacons at intervals of 5 to 15 miles for points of reference for the Marine Survey, fixing their positions and also the positions of other conspicuous objects.

2. The country having been previously triangulated by the Madras Coast Series party under Major Strange and Mr. Clarkson in 1858-59 and 1859-60, a careful search for the old stations was made, and very nearly all on the inland flank of the series were found and identified; of the stations on the seaward flank, those which were on hill-tops, where the station marks were made on rocks *in situ*, were traced, but, as was expected, none of those on sand mounds were found as they were of a temporary character. Sufficient data was, however, afforded by the old stations which were identified to form bases for the triangulation needed to determine the positions of the beacons constructed by the party as well as those built by the Marine Department, light-houses, and other conspicuous objects and landmarks.

3. In the course of the season's operations, 1,240 square miles of country have been traversed, 600 miles of which have been covered with fresh triangles by which the positions of 20 beacons were determined, and, in addition, 4 light-houses and 83 permanent and conspicuous objects were fixed.

4. The old triangulation executed on this coast by the Madras Coast Series was carried only as far as Coringa: it has now been continued south as far as the Godávari river, where the difficult nature of the country as well as the approaching south-west monsoon compelled the party to close work on the 12th of May and return to head-quarters.

5. The beacons were all built of *pakka* brick masonry, obelisk-shaped, 15 to 24 feet in height and 5 to 7 feet square at base. Great care was taken to select good sites for the erection of these beacons, not only to ensure their being visible from a distance at sea, but also to secure their permanency. All the stations and beacons have been placed under the care of the local officials, so that the Marine Survey Department may obtain points of reference readily and with certainty.

6. The country through which the season's operations were carried on was that bordering on the coast from Kovita Station $\frac{\text{Lat. } 19^\circ\ 2'}{\text{Long. } 84^\circ\ 44'}$ to the mouth of the Godávari $\frac{\text{Lat. } 16^\circ\ 42'}{\text{Long. } 82^\circ\ 20'}$, about 240 miles in a direct line, covering the ground of three different districts—Ganjam, Vizagapatam, and Godávari. It is generally a fertile country and well populated, containing several large towns and seaports.

7. During the recess all the angle books were examined and the abstracts made in duplicate: 40 triangles, of which 3 angles have been observed, 146 triangles of tertiary points, and the heights of 27 stations have been computed. A general report of the season's work has been prepared for incorporation with the Synoptical Volume as well as an alphabetical list and synopsis of latitudes,

longitudes, and heights, and four preliminary charts have been drawn on the scale of 2 inches to the mile with data.

8. The extract from Narrative Report will be found at page i of the Appendix.*

TOPOGRAPHY.

ANDAMAN SURVEY.

9. The Topographical Operations carried on by the Andaman Party during the season under report, consist of a survey on the scale of 4 inches = 1 mile of a portion of the South Andaman Island, and a general survey of the group of islands on the scale of ½ inch = 1 mile. The large scale survey is being conducted to facilitate the development of the British Settlement at Port Blair, whilst the latter adds to our geographical knowledge and furnishes valuable data for future hydrographical research—*vide* Index map.

10. The party left Calcutta in the mail steamer "*Maharani*" on the 21st November 1884, arriving at Port Blair on the 24th of the same month. The field season closed on the 23rd May 1885.

Personnel.

Captain J. R. Hobday, Officiating Deputy Superintendent, 4th grade, in charge.
Mr. G. D. Cusson, Assistant Surveyor, 1st grade.
Mr. J. Keating, ,, 2nd grade.
Mr. D. Campbell, ,, 2nd grade.

Sub-Surveyors.

Harlall Sing. | Niaz Hossein.
Faida Ali. |

Apprentice Ali Nawaz Khan.

11. It is believed that no more arduous operations have ever been entrusted to the officers of the Survey of India. Captain Hobday is possessed of energy, activity and resource, and his assistants have manfully supported him. To the exhausting climate and the difficulty of working in a hilly, forest-clad and hitherto little known series of islands, inhabited solely by savages, have been added the experience new to landsmen of working in boats and the danger of actual shipwreck—the steamer "*Reclaimer*" having foundered on an unknown rock. At the same time the difficulty in obtaining food in those inhospitable islands has aggravated the hardships falling to the lot of these Surveyors.

12. The triangulation was extended, this year, as far as the Middle Andaman or latitude 12°45′, covering an area of about 1,000 square miles; also the station on Saddle Peak, in the North Andaman Island, has been cleared of forest and a markstone embedded. The area remaining to complete the triangulation is about 900 square miles.

13. On the scale of 4 inches = 1 mile, an area of 111 square miles of country was surveyed. This has proved a laborious undertaking, as Captain Hobday reports, "we have had to cut our way foot by foot, through one of the most stupendous forests in the world." There remain only about 30 or 40 square miles to complete the area contemplated for survey on this scale.

14. On the scale of ½ inch = 1 mile about 670 square miles of the islands were surveyed, leaving about 1,500 square miles to complete.

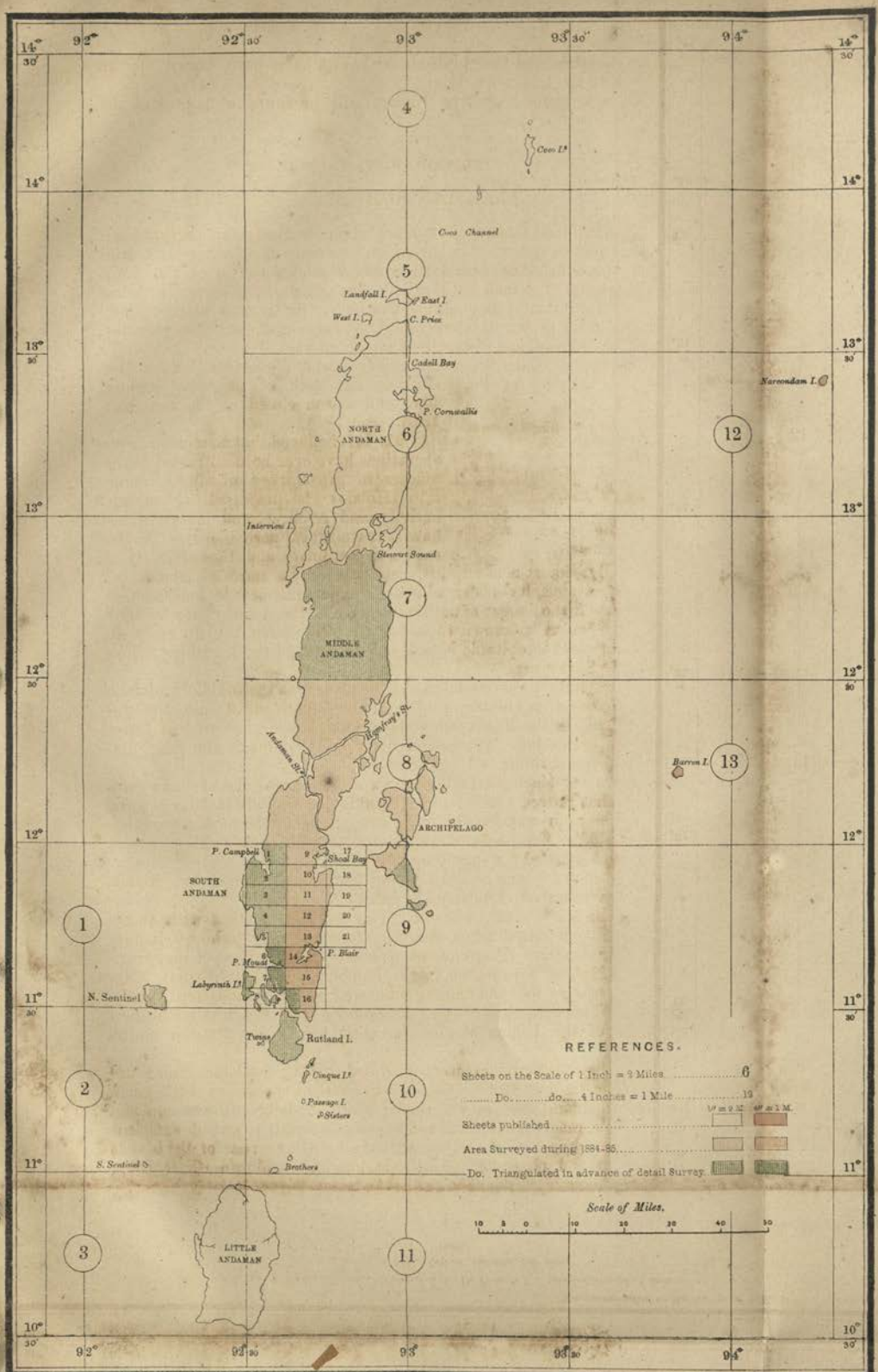
15. During the recess sheet 14 has been redrawn and together with sheets 12, 13 and 15, all contoured maps, has been forwarded for publication, also sheet 8 on the ½ inch scale. There are no arrears of computations or mapping.

16. Captain Hobday says he was much indebted to Colonel Cadell, V.C., the Chief Commissioner, and the officers connected with the Settlement for the assistance rendered after the loss of the "*Reclaimer*;" also to Captain Cuthbert and the officers of the Indian Marine for their hearty co-operation on all occasions.

17. During the coming field season, provided that the Settlement can afford sufficient assistance, Captain Hobday proposes to complete the survey of the Andaman Islands; and should the survey of the Nicobar Islands be still contemplated an endeavour will be made, should time and opportunity avail, to provide sufficient data for their survey by selecting and measuring a base line on one of the islands forming the group and observing for latitude, longitude and azimuth, it being impossible to connect these islands with the Andaman triangulation.

* Mr. D'Souza speaks very favourably of the assistance he received from Mr. C. D. Potter.

INDEX TO THE SHEETS OF THE ANDAMAN TOPOGRAPHICAL SURVEY.



Photozincographed at the Survey of India Offices, Calcutta.

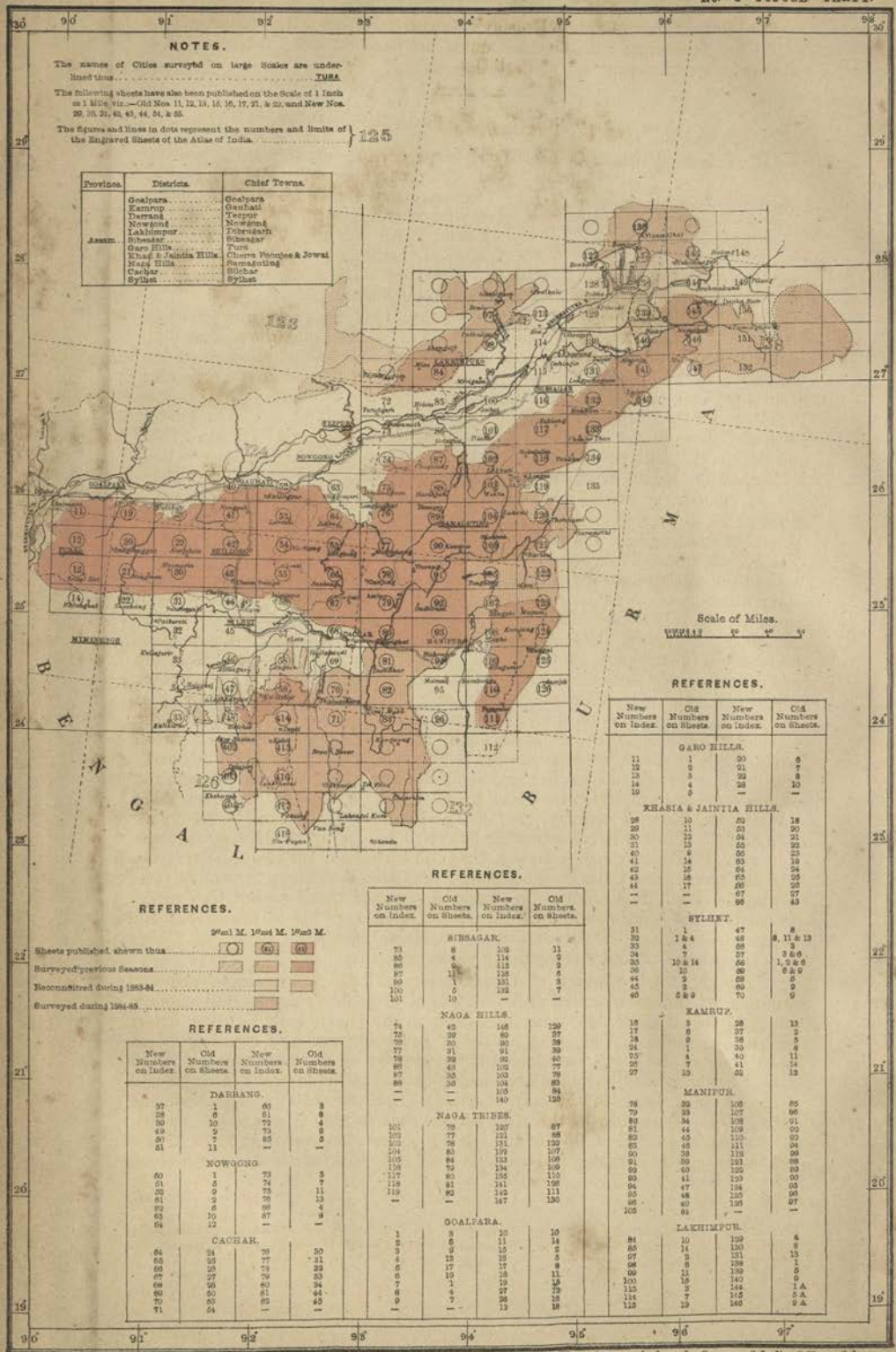
Published under the direction of Colonel G. C. De Prée, S. C., *Surveyor General of India.*

Survey of India Offices, Calcutta, February

1886.

INDEX TO THE GARO, KHASI & NAGA HILLS & N.E. FRONTIER SURVEY.

No. 6 TOPOGL. PARTY.


NOTES.
The names of Cities surveyed on large Scales are underlined thus..... TURA
The following sheets have also been published on the Scale of 1 Inch on 1 Mile, viz.:—Old Nos. 11, 12, 13, 15, 16, 17, 21, & 22; and New Nos. 29, 30, 31, 43, 43, 44, 54, & 55.
The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India. 125
Province | Districts | Chief Towns
Assam | Goalpara | Goalpara
Kamrup | Gauhati
Darrang | Tezpur
Nowgong | Nowgong
Lakhimpur | Dibrugarh
Sibsagar | Sibsagar
Garo Hills | Tura
Khasi & Jaintia Hills | Cherra Poonjee & Jowai
Naga Hills | Samagooting
Cachar | Silchar
Sylhet | Sylhet
Scale of Miles.
BENGAL
BURMA
REFERENCES.
Sheets published, shewn thus
Surveyed previous Seasons
Reconnoitred during 1883-84
Surveyed during 1884-85
REFERENCES.
REFERENCES.
REFERENCES.

New Numbers on Index.	Old Numbers on Sheets.	New Numbers on Index.	Old Numbers on Sheets.
GARO HILLS.			
11	1	20	6
12	2	21	7
13	3	22	8
14	4	28	10
19	5	—	—
KHASIA & JAINTIA HILLS.			
28	10	52	18
29	11	53	20
30	12	54	21
31	13	55	22
40	8	56	23
41	14	63	19
42	15	64	24
43	16	65	25
44	17	66	26
—	—	67	27
—	—	68	43
SYLHET.			
31	1	47	8
32	1 & 4	48	8, 11 & 13
33	4	58	8
34	4	57	3 & 6
35	10 & 14	58	1, 2 & 6
36	10	59	8 & 9
44	9	69	9
45	9	60	9
46	5 & 9	70	9
KAMRUP.			
16	3	28	13
17	6	37	2
18	9	38	5
24	1	39	6
25	4	40	11
26	7	41	14
27	13	52	12
MANIPUR.			
78	32	106	85
79	33	107	86
80	34	108	91
81	44	109	92
82	45	110	92
83	46	111	94
90	39	118	89
91	89	123	88
92	60	125	89
93	61	126	90
94	47	134	95
95	48	135	96
96	49	136	97
105	91	—	—
LAKHIMPUR.			
84	10	129	4
85	14	130	8
97	3	131	13
98	8	132	1
99	11	139	5
100	15	140	9
113	3	144	1 A
114	7	145	5 A
115	19	146	9 A

New Numbers on Index.	Old Numbers on Sheets.	New Numbers on Index.	Old Numbers on Sheets.
SIBSAGAR.			
73	8	103	11
85	4	114	9
86	9	115	9
87	13	128	6
99	1	135	3
100	5	136	7
101	10	—	—
NAGA HILLS.			
74	42	148	129
75	39	89	97
76	30	90	98
77	31	91	99
78	32	92	40
86	43	102	77
87	35	103	78
88	36	104	83
—	—	105	84
—	—	140	128
NAGA TRIBES.			
101	76	127	87
102	77	121	88
103	78	131	129
104	83	132	107
105	84	133	108
116	79	134	109
117	80	135	110
118	81	141	126
119	82	142	111
—	—	147	130
GOALPARA.			
1	3	10	10
2	6	11	14
3	9	12	5
4	13	15	5
5	17	16	9
6	19	18	11
7	1	19	15
8	4	27	19
9	7	26	18
—	—	13	18

New Numbers on Index.	Old Numbers on Sheets.	New Numbers on Index.	Old Numbers on Sheets.
DARRANG.			
37	1	60	3
38	6	61	6
39	10	72	4
49	2	73	8
50	7	85	1
51	11	—	—
NOWGONG.			
50	1	73	5
51	5	74	7
52	9	75	11
61	3	76	13
62	6	86	4
63	10	87	8
64	12	—	—
CACHAR.			
64	24	76	30
65	25	77	31
66	28	78	33
67	27	79	32
68	26	80	34
69	30	81	44
70	29	82	45
71	34	—	—

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Survey of India Offices, Calcutta, February 1886

18. Extracts from Captain Hobday's Narrative Report will be found on page iv of the Appendix; and the cost rates on page 62 and the summary of out-turn of work on page 60 of Part II.*

ASSAM AND NORTH-EAST FRONTIER SURVEY.

19. This party, under Colonel Woodthorpe, carried out, during the past season, the programme originally proposed for 1883-84, *viz.*, the exploration of the country on the extreme north-eastern frontier of Assam, with the object of mapping as much of the Singpho hills as possible, and of reporting on the routes leading into Burma and China.

Personnel.

Brevet-Lieutenant-Colonel R. G. Woodthorpe, R.E., Deputy Superintendent, 4th grade, in charge.
Mr. M. J. Ogle, Surveyor, 3rd grade.
,, A. Ewing, Assistant Surveyor, 3rd grade.

Sub-Surveyors, &c.

Shah Nasiruddin, Mahomed Hussain, one Writer and one Hospital Assistant.

20. Leaving Shillong on the 16th November 1884, the party was joined at Gauhatti by Dr. D. St. J. Grant, Indian Medical Department, who took medical charge thereof; on their arrival at Dibrugarh on the 3rd December, Mr. LaTouche, of the Geological Survey, joined them, as well as an escort, consisting of 46 sepoys of the 44th Assam Light Infantry and 20 men of the Frontier Police, under the command of Major C. R. Macgregor, B.S.C. The expedition reached Saikwa in the immediate neighbourhood of Sadiya on 17th December, and left on the 19th accompanied by the Assistant Political Officer, reaching Ndong, on the Dihing river, on the 25th idem.

21. The party commenced survey operations on the 27th December. Separating at Ndong, one detachment proceeded to clear the G. T. Station of Maiobum and to select another higher point about 4 miles to the east; a second detachment, taking 17 days' provisions, proceeded to the G. T. Station of Maium beyond the easternmost of the Morang-Naga villages, to make the preliminary observations for the extension eastwards of the necessary triangulation, which is based on the side Sadiya-Maiobum of the Assam valley series of the Great Trigonometrical Survey. Colonel Woodthorpe with the remainder of the party first revised the mapping, on the $\frac{1}{2}$ inch scale, of the country between Maiobum and Nunnun, originally done in 1876-77, and then sketched some new country to the north and east on the same scale, after which he took up the survey of the Wangleobum range on the $\frac{1}{4}$ inch scale, finishing near Ting-Kong Pathar. Colonel Woodthorpe then, accompanied by Major Macgregor and a very small party, made an excursion into the Bor Kampti country where he and his party were well received, and he managed to fix the positions of several villages and secure some topography on the $\frac{1}{4}$ and $\frac{1}{8}$ inch scales. After a short sojourn of six days in the Kampti country, they retraced their steps to Kumki and thence explored the Turong river, returning finally to Ndong by the Nongyong lake and over the Patkai range. Messrs. Ogle and Ewing and the two sub-surveyors did not accompany Colonel Woodthorpe into the Bor Kampti country. Mr. Ewing and Shah Nasiruddin were condemned to inaction for some time owing to carriage not being procurable. A detailed account of the adventures of the party will be found in the extracts from Major Macgregor's and Mr. Ogle's reports, at pages x and v respectively of the appendix.

22. The total out-turn of triangulation is 3,610 square miles and the number of stations observed at 5. The total area surveyed in detail amounts on the $\frac{1}{8}$ inch scale to 245 square miles and on the $\frac{1}{4}$ inch scale to 1,945 square miles. In addition, 630 square miles of route surveys and reconnaissances were done on the $\frac{1}{8}$ inch scale, and 107 linear miles of traverses were run.

23. The country triangulated and plane-tabled embraces a large tract of Singpho hills lying to the east of the G. T. Stations Jaitu, Maiobum and Maium, and extending to the Mile Kha or river in the Bor Kampti country. This tract lies between 96° 10′ and 97° 45′ of east longitude, and 27° 15′ and 27° 40′ of north latitude, and embraces country both north and south of the

* Captain Hobday brings to notice the commendable zeal displayed by the assistants, especially Messrs. Keating and Campbell, and sub-surveyors of the Andaman Party, who have all worked to his entire satisfaction both in the field and during recess.

Dihing (or Diyun) river. The whole of this region is densely wooded, and owing to a want of paths, extremely difficult to move about in. A departure from a track to ascend a hill top entailed hard cutting through cane brakes and bamboos, and in many places digging steps to get a foothold over steep slopes. Progress on these occasions was necessarily slow and rarely exceeded 2 miles a day. The point desired to be attained had to be sought without the aid of a guide, which added considerably to the difficulty of the situation, and to reach a hill 8 miles off as the crow flies, or say about 11 miles by road, would occupy some 6 days, while the return journey could be performed probably in as many hours.

24. There are only two villages in the portion of the Singpho hills traversed by the party, *viz.*, Kumki and Timolia, both situated in a small valley on the banks of the Diyun river.* The rest is an uninhabited, forest-clad, hilly tract, the height of the hills ranging from 1,500 to 15,000 feet above sea-level. The principal rivers are the Diyun in the north and the Turong Kong in the south.

25. Only two paths exist in this tangled network of jungle: one follows the bed of the Diyun river to its head, crosses over the Chaukam pass at an elevation of 8,500 feet and enters the Bor Kampti country; the other leaves the first path at Inling on the Dihing river and, striking due south, follows the Namphuk river, then passes over the Patkai range (elevation 2,860 feet) where it leaves Assam. It then descends the water-shed, passes by the Nongyong lake, and following the Loglai and Turong Kong rivers, again passes over the Patkai range into Kumki where it re-joins the other path. These paths had to be improved in many places and sometimes hand-rails put up before a passage could be effected.

26. The constant wading through rivers, combined with the attacks of leeches and the pipsa fly, occasioned great suffering to all members of the party. Amongst the coolies specially disease was rife, due to exposure and want of proper food. Twelve of them died from sickness, two were killed by a tiger and two others disappeared, and nothing is known of their fate.

27. The rainfall was very heavy. There were 63 rainy days between 1st January and 30th April. The rivers rose so rapidly that they became unfordable sometimes in the course of a few hours and occasionally remained so for days. Great caution had therefore to be exercised to avoid being cut off from provision depôts.

28. After great hardships, owing to the lateness of the season, the party returned from Kumki by the Nongyong route over the Patkai range and re-entered Assam on the 15th April. Their troubles, however, were not over yet as the Dihing river was found to be so swollen that they were unable to cross for three days. The Namphuk had previously been crossed with great difficulty and the last supply of food had been served out. On the 27th April the party arrived at Sadiya, and Shillong was reached on the 17th May.

29. Neither of the routes explored by the party can be utilized without considerable expenditure of money in opening them out. The heavy rainfall at one season and the existence of snow on the passes at another, renders them impracticable during about eight months of the year.

30. On the arrival of the party at Shillong, Colonel Woodthorpe received orders for special duty on foreign service and the party was transferred to Calcutta where, during a very short recess of two months, the computations and mapping were brought up as far as possible. Owing to the transfer of the officer in charge and the breaking up of the party, the recess duties fell very heavily on the few members who remained.

31. On the 16th July 1885 the party ceased to exist and its members were distributed amongst various other parties.

32. A brief retrospect of the history of this party since its formation will be found in the extracts from Mr. Ogle's report at page v of the appendix.

33. It is impossible to give a reliable cost rate for this party owing to the peculiar nature of its operations and of the country. †

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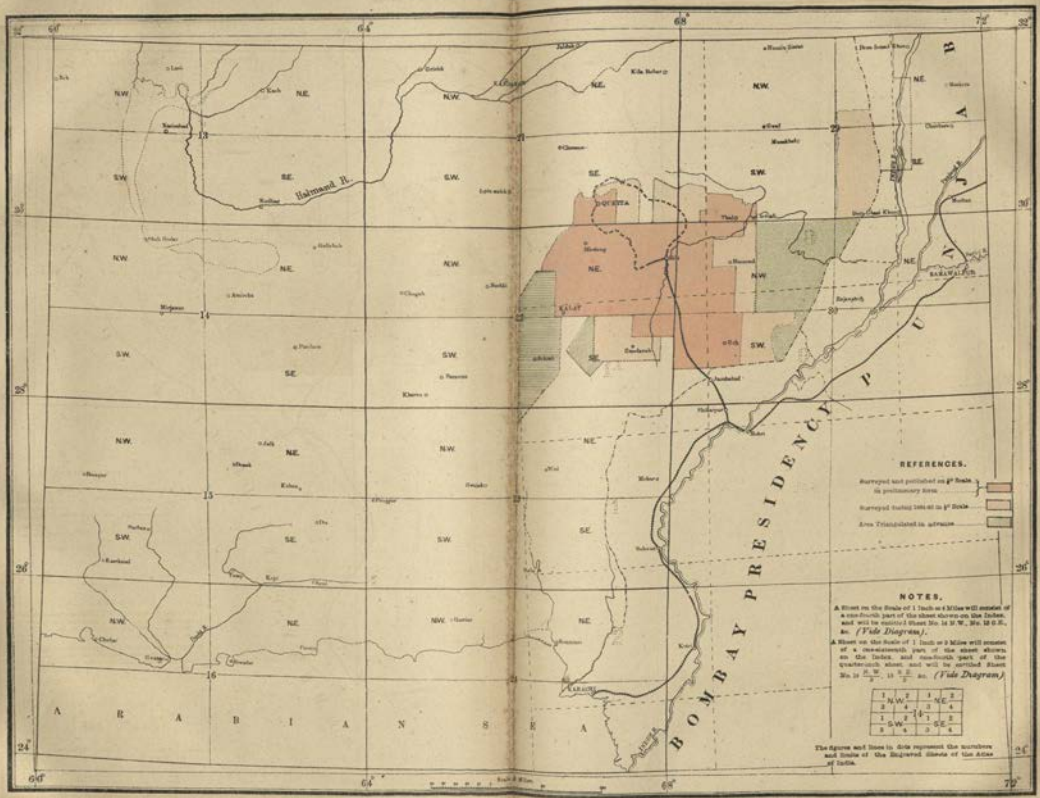
* Major Macgregor calls the valley Kumki and the villages Timla or Tingsa and Bamjan or Bumgaon.

† Colonel Woodthorpe speaks in the highest terms of Mr. Ogle and the sub-surveyors, and mentions the cheerful assistance in every way given by Major Macgregor, Dr. Grant and Mr. LaTouche, as well as by the sepoys of his escort.

Survey of India Department.

INDEX TO THE BALUCHISTAN SURVEY, NORTH WESTERN TRANS-FRONTIER.

On the Scales of 1 Inch = 4 Miles and 2 Miles.



Published under the direction of Colonel G.T. Du Prée, R.C., Surveyor General of India.

Survey of India Office, Calcutta, March.

1895.

Photo-lithographed at the Survey of India Offices, Calcutta.

BALUCHISTAN SURVEY.

34. During the season the Baluchistan Party continued its regular work on the $\frac{1}{2}$″ scale within the limits of the Baluchistan Agency, and a large area beyond the frontier was reconnoitred by the detachment accompanying the Zhob Valley Expedition, while the survey of the Punjab Frontier has been extended to Dera Gházi Khán.

Personnel.

Major T. Holdich, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Lieutenant R. A. Wahab, R.E., Assistant Superintendent, 1st grade.
Mr. G. B. Scott, Surveyor, 1st grade (now Assistant Superintendent).
Mr. T. E. M. Claudius, Surveyor, 4th grade.
„ G. R. Copping, Assistant Surveyor, 1st grade.
„ A. Kitchen, „ „ 1st „

Sub-Surveyors.

Yusuf Sherif.	Barkat Ali.
Imam Bux Bozdar, Khan Bahadur.	Kadir Sharif.
Abdul Rasul.	Futteh Mahomad, writer.

35. Prior to the commencement of the field season, Lieutenant the Honourable M. G. Talbot, R.E., and Sub-Surveyors Hira Singh and Ata Mahomed were selected for service with the Afghan Boundary Commission, and transferred to the Foreign Department, so that the nominal strength of the party on taking the field was as per margin; but before work was commenced Major Holdich, who had been recalled from furlough to command the detachment about to enter the Zhob country, was transferred to the charge of the survey operations with the Afghan Boundary Commission, in place of Major J. Hill, R.E., on account of the latter's ill-health; and Lieutenant Wahab, Mr. Scott, and Yusuf Sherif were ordered to accompany the Zhob Valley field force, and did not rejoin the party till 17th December 1884. By the death of Mr. Copping on 27th November, the strength of the party was further reduced, and again by the invaliding of Mr. Scott on his return from the Zhob Valley.

36. In consequence of the considerable reduction of the *personnel*, together with the exceptionally wet and cloudy weather experienced during the latter half of the season, the total out-turn is somewhat less than that of the previous season. A considerable extension of detail survey has, however, been made, and much has been done, by filling in gaps unavoidably left in the work of previous seasons, towards the methodical publication of the results of the survey in complete standard sheets.

37. The party left the field depôt at Jacobabad on the 13th November 1884, with the exception of the Zhob detachment, which took the field early in September, and work was commenced between the 15th and 20th idem under the superintendence of Mr. Claudius, who retained charge of the party till the return of Lieutenant Wahab. All the detail Surveyors completed their work by the end of April, except Mr. W. W. McNair. He joined the party late in February 1885, and part of the work he took up embraced a considerable tract of high mountainous country, the climate of which being fairly cool he was enabled to remain at work till the end of May.

38. Mr. Claudius commenced reconnoitring and laying out a short series of triangulation, starting from the base Barshori-Khekri of the Baluchistan series of the Great Trigonometrical Survey near Jacobabad, and closing on the stations of the Baluchistan survey in the hill country east of Kalát. This work was, however, interrupted by the sudden death of Mr. Copping which necessitated Mr. Claudius' presence at Sibi, but was subsequently continued and completed by Captain Wahab in January and February. The length of this series is only 45 miles, but owing to the nature of the country—an absolutely flat plain devoid of any features—eight intermediate stations were necessary, and great difficulty and delay were experienced in getting inter-visible stations even with the short sides of 5 or 6 miles. Again on the eastern frontier line with a view to establishing a stronger connection between the triangulation executed during the Zhob Expedition and the points fixed by the Great Trigonometrical Survey from the Great Indus series on the Sulemán range, Sub-Surveyor Yusuf Sherif, who was engaged on a detail survey of the Deraját frontier, was instructed to take observations with a 5″ theodolite from such points as he might be able to visit during his operations. He succeeded in observing at three stations, intersected points of the Great Trigonometrical Survey, and his observations have been combined with those of the Zhob triangulation with most satisfactory results. The total area triangulated during the season amounts to 1,480 square miles.

39. The out-turn of topographical survey is 7,717 square miles on the $\frac{1}{2}$" scale. This includes a most important bit of hitherto unexplored country, which stretches from the lower part of the Harnái valley northwards to the pass connecting the Bori and Smalan valleys and contains the railway, the survey of which has been of immediate value in determining the best lines for the projected roads through this difficult country. Portions of the Bugti country, comprising the lower ranges of hills between Thal Chotiáli and the Jacobabad districts, were also surveyed in detail, as well as the Deraját frontier, the Kachni or plain around Gandáváh, and the hilly country to the west, through which the lower portions of the Gazak and Takári passes to Kalát run.

40. Thus it will be seen that this year the operations of the party were extended over a very wide area of country from the Sulemán range on the east to the Kalát hills on the west, consisting for the most part of barren rocky hills and equally barren valleys, sparsely populated by Biluch and Pathán tribes. Supplies have to be brought from a long distance and drinking water is generally scanty and often brackish. The elevation of the country on the west of the passes is considerable; most of the valleys are over 2,000 feet, and many of the Surveyors' camps were over 5,000 feet above sea level: in the winter months the cold is therefore very severe, and the rigours of the climate were enhanced during the past season by the abnormally heavy rain and snow during January, March, and April. In spite of these drawbacks the country is on the whole an easy one to survey. There is very little cultivation and no jungle, except among the higher hills north of Harnái, where occasional patches of juniper forest are found. Between the hill ranges there are often broad stretches of open country, which a skilful plane-tabler can sketch from a comparatively small number of fixings on the surrounding ridges, and though the country is covered with lofty mountain ranges, the communications are by no means difficult, one of the peculiar characteristics of the drainage system being the manner in which rivers break through what at first sight seem continuous ranges, and thus give unexpectedly easy access from one valley to another.

41. A further description of the country will be found in the appendix to this report and also in that of last year, and there is an interesting memorandum in the Gazetteer of Afghanistan by Mr. O. T. Duke, of the Baluchistan Agency, in which full details are given of the inhabitants of the Harnái district (more properly called Záwar) with recent statistics of the population, area under cultivation, produce, revenue, &c.

42. The only district which does not come under the above general description is the Kachhi, where the climate and general conditions resemble those of the adjacent Sind plains, and except in a few favoured spots irrigated by flood water from the hills or canals from the Indus, there is scarcely a feature to be seen, in a day's journey, for the plane-tabler to record on his board.

43. In such a country triangulation is a most tedious and difficult operation. There are no *pakka* buildings in the country, and the only existing points available for stations were the highest houses in villages, whose flat mud roofs were always too shaky for theodolite stations. A simple method of isolating the instrument was tried in several cases and proved fairly satisfactory. Two pairs of tent-poles were lashed together, and laid so as to rest on the walls of the house—generally a few inches higher than the roof—and connected with short cross pieces. On this frame the theodolite was set up, being thus supported by the walls of the house, practically independent of the roof which formed the platform for the observer.

44. The hours are very limited during which theodolite observations are possible. Horizontal angles could not be observed after about 8 A.M. or before 4 P.M. owing to the extraordinary effects of the *mirage* over the heated *pat* and vertical observations could not be taken in the heat of the day except to heliotropes, all opaque objects being blurred and unrecognisable. Much delay was therefore caused by the cloudy weather which lasted through a great part of January and February.

45. The health of the party was on the whole good, therefore the death of Mr. Copping is the more to be regretted. Captain Wahab says he was a young surveyor of great promise, and his loss is a serious one to the party with which he had served six years. Suddenly taken ill in one of the most desolate spots on the frontier, he was being carried into Sibi by his khalassies when he

died, it is supposed, from fever. Cholera attacked Mr. Kitchen's camp in the Harnái valley, and two deaths occurred among the escort. Fever was, as usual, very prevalent amongst the khalassies in the first few months of the season, but the warm clothing and ample rations issued to the men doubtless prevented its becoming serious and chronic. The extremes of temperature met with in this country are very trying to both Europeans and natives of India, which, combined with its sterile nature, renders the work particularly arduous.

46. The survey of Baluchistan was commenced in 1879, and up to date a total area of 14,484 square miles has been surveyed more or less accurately on the $\frac{1}{2}''$ scale, and 2,800 on the $\frac{1}{4}''$ scale as opportunities have offered. Captain Wahab reports that throughout the progress of the frontier survey, now complete from Peshawar to Dera Gházi Khán, every assistance has been given to this Department by the different frontier officers, to whose cordial co-operation its success is greatly due.

47. During the recess the triangulation executed during the Zhob Valley Expedition has been recomputed, from a base well connected with the Great Indus Series, in preference to that adopted in the original field computations, which had been brought up by a somewhat weak triangulation, depending on preliminary data furnished by the Great Trigonometrical Baluchistan Series. The triangulation is checked to some extent by several points fixed by it on the Sulémán range, which are identical, or nearly so, with those intersected by the Great Trigonometrical Survey from the Great Indus Series. The agreement is as close as could be expected under the circumstances, the mean errors deduced from 5 common points being $0''{\cdot}68$ in latitude and $0''{\cdot}16$ in longitude. The most northerly points Kaisarghar and the Takht-i-Sulémán do not agree so well; they are fixed by long rays and acute intersections, and are evidently not equally reliable.

48. The value of refraction obtained from the vertical observations is ·057 of the contained arc, somewhat smaller than that deduced from the observations in North Afghanistan, which was ·080. Those observations were, however, taken at all seasons of the year, while the results under report were from angles observed during October and November, when refraction is probably at its minimum. The value obtained from a large number of reciprocial observations in South-West Baluchistan in the cold weather of 1883-84 was ·060.

49. The short series of triangulation carried out during the season, connecting the Baluchistan series near Jacobabad with the previous triangulation of this party west of Gandáváh, has also been computed; the discrepancy at the closing station is only $0''{\cdot}11$ in latitude and $0''{\cdot}98$ in longitude.

50. General reports of sheets Nos. 30, N. E. and N. W., are being compiled, but owing to the party taking the field early in October are not completed. The general report of the triangulation of South-West Baluchistan is also under preparation, and those computations which remained unfinished last recess season have now been completed. This triangulation covers the greater part of sheets Nos. 22, N. W. and S. W.; 23, N. W. and S. W.; and 15, N. E. and S. E.: points have been fixed as far west as 62° 52′ longitude, within Persian limits, and south as far as 25° 53′ latitude, within 40 miles of the Mekran coast. The general report of the Zhob triangulation has also been prepared, to illustrate which charts have been drawn, 2 sheets of the South-West Baluchistan triangulation, and 4 sheets of the regular survey by degree sheets.

51. The following standard sheets have been drawn: Nos. 30 $\frac{\text{N. W.}}{1}$, $\frac{\text{N. W.}}{3}$, $\frac{\text{S. W.}}{1}$, complete, and Nos. 29 $\frac{\text{N. E.}}{3}$, $\frac{\text{S. E.}}{1}$, $\frac{\text{S. E.}}{3}$, $\frac{\text{S. W.}}{3}$, as far as the ground within their limits has been surveyed. All these have been prepared as regular sheets on the basis of the North-West Trans-Frontier Index Map: portions of some of these sheets had previously been published in irregular preliminary form. Two sheets have still to be drawn, Nos. 22 $\frac{\text{N. E.}}{2}$ and $\frac{\text{N. E.}}{4}$, to complete the final mapping of the area surveyed, of which the greater part has been published, but in irregular form and roughly drawn, some portions having been photo-zincographed from the original field sections. At the earliest opportunity they will be compiled in regular standard sheets.

52. During the coming season the party will be employed on the Khwája Amran range of hills west of Pishín, which will be surveyed on the 2″ scale with some special portions on the 6″, in accordance with the requirements of the

Quarter Master General's Department. One Surveyor, or perhaps two, will be occupied for the first few months of the season, in completing the survey of the Harnái valley, and in the spring, if the strength of the party permits, the triangulation of the Toba plateau, north-east of Pishín, is to be undertaken.

53. The charge of the party next year will be entrusted to Lieutenant-Colonel J. R. Wilmer, Captain Wahab having been transferred to the Cadastral Survey to obtain a training in that special system; he is, however, available for re-transfer on a demand for his services arising.

54. Extracts from Captain Wahab's Narrative Report will be found at p. xxii of the appendix, and the cost rates at p. 62 Part II.*

CUTCH SURVEY.

55. The party, as marginally noted, left Poona on the 3rd November 1884, and proceeded to Cutch, in which country they carried on field operations until the 7th May 1885, and on the 11th office for recess work was again opened at Poona.

Personnel.

Lieutenant-Colonel A. Pullan, S.C., Deputy Superintendent in charge.
Mr. N. C. Gwynne, Surveyor, 3rd grade.
„ W. A. Fielding, Assistant Surveyor, 1st grade.
„ G. T. Hall, „ 1st „
„ H. A. Charrier, „ 3rd „

Sub-Surveyors.

N. D. Patwardhan, and seven others.

After ten days spent in Mándvi in overhauling and repairing camp equipage and the cleaning of instruments, testing of chains and the preparation of the various plane-table sections, the party proceeded by regular marches to the ground prepared for topographical operations.

56. Mr. Fielding was in charge of the tertiary triangulation and triangulated 2,120 square miles in advance, thus doing a very good season's work.

57. During the season 754 linear miles of traverse were run, 350 miles as a check on the plane-table survey, and 404 to supply-points along the Rann and grass wastes adjacent to that desert; 1,641 square miles were topographically surveyed with the plane table on the scale of 2 inches = 1 mile, 612 square miles on the $\frac{1}{2}$" scale, and the Military Cantonment and City of Bhuj with environs covering an area of 11·8 square miles, on the scale of 12 inches =1 mile, giving a total out-turn of 2,264·8 square miles.

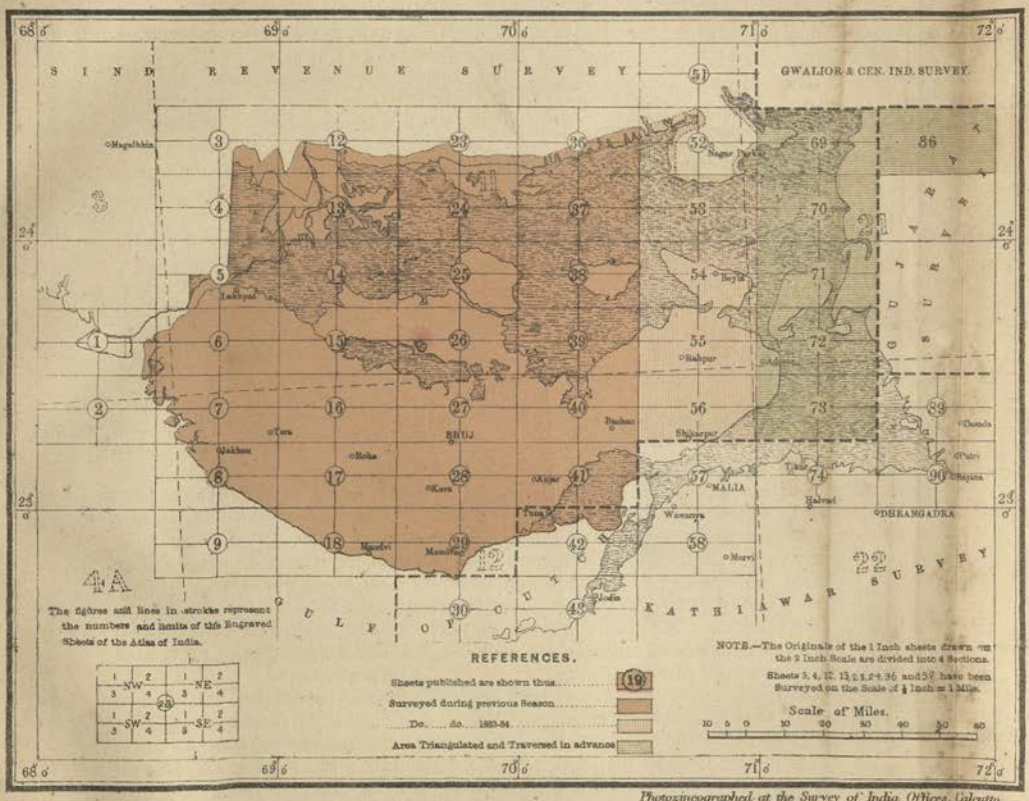
58. Sheet 52, 5 plane-tables in 54, and 2 plane-tables of 55 were examined *in situ* by Lieutenant-Colonel Pullan, after which he met with an accident, having been attacked by a panther, and the remainder were examined by Messrs. N. C. Gwynne and G. T. Hall. When again able to walk, Lieutenant-Colonel Pullan examined the whole of the plane-table sections of the Bhuj Survey.

59. The topographical survey comprised sheets 52, 53, 54, 55, and 56. Sheets 52 and 53 contain the Rann, where it abuts on the Sind province of Thar and Párkar, and is devoid of interest. Sheets 54, 55, and 56 are poorly cultivated and covered with low hills and cactus jungle. The peninsula of Pránthal is the principal feature of sheet 54, a rugged and sterile tract containing 10 villages, the most important being Bela, population 4,191, and Lodhrani, population 1,855. Sheets 55 and 56 are on the Cutch mainland, and the country is similar in character to 54. The principal towns are Rahpur, population 4,603, Bhimasar, population 2,940, Fategadh, population 4,159. At Rahpur there is a Post Office and Dispensary. Adhoi, belonging to the Thakur of Morvi, is a large town with a population of 5,025.

60. It is proposed during the field season of 1885-86 to survey topographically on a scale of 2 inches=1 mile, sheets 69, 70, 71, 72, and 73 of Cutch and sheet 85 of Gujarát. This survey, commenced in 1879, is expected to be completed in 1886, when the field party will probably be transferred to the Central Provinces.

* Captain Wahab reports that Mr. Claudius, who on former occasions has received most favourable notice, again displayed more than ordinary skill and forethought in the varied arrangements for the party on taking the field and in the distribution and efficient conduct of the field duties. Mr. McNair is a skilful and rapid topographer, and Mr. Kitchen's out-turn under most trying circumstances does him the greatest credit. Of the Sub-Surveyors Yusuf Sherif and Imam Bux worked excellently under considerable risk and hardships, and Kadir Sharif's work was very creditable.

INDEX TO THE SHEETS OF THE CUTCH TOPOGRAPHICAL SURVEY.



Photozincographed at the Survey of India Offices, Calcutta.

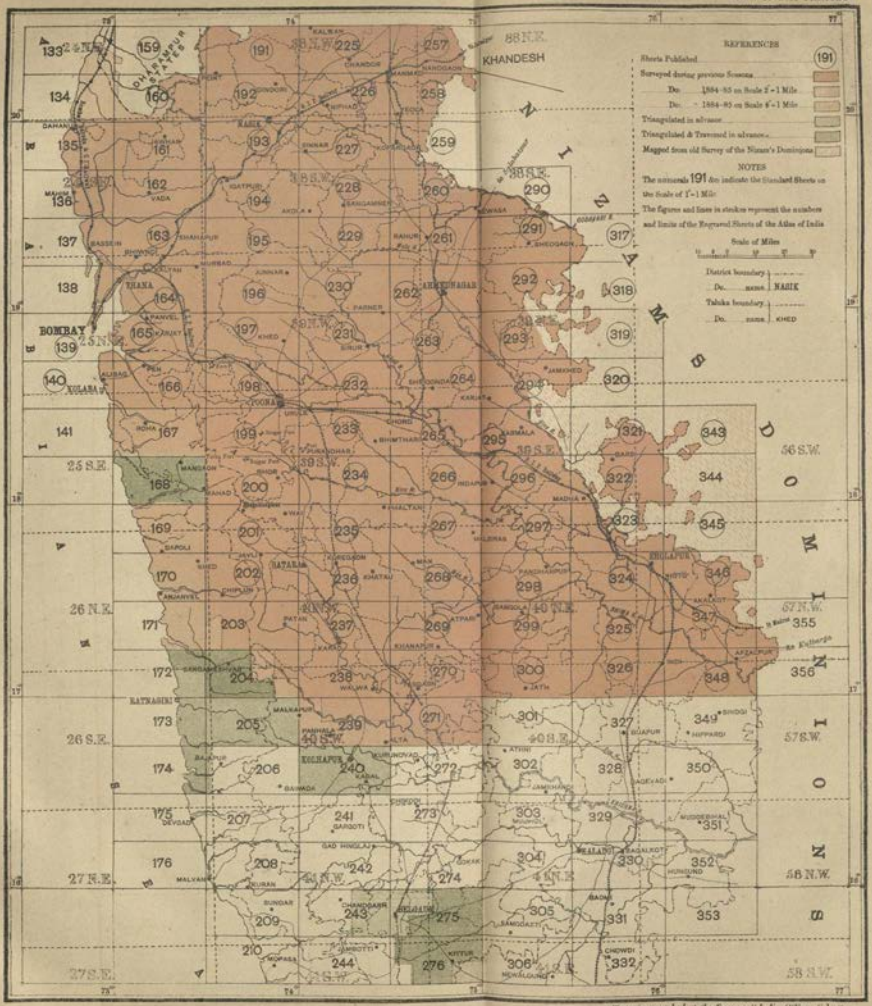
Each sheet on the Scale of 1 Inch = 1 Mile is divided into four on the Scale of 2 Inches = 1 Mile, and is entitled, 26 N.W., 26 N.E. These 2-Inch sheets are again sub divided into four sheets on the Scale of 4 Inches = 1 Mile, and are entitled $26\frac{N.W.}{1}$, $26\frac{N.E.}{2}$ according to their positions *Vide Diagram.*

Published under the direction of Colonel G. C. De Prée, S.C., *Surveyor General of India.*
Survey of India Offices, Calcutta, February
1886

BOMBAY SURVEY

INDEX TO THE SURVEY OPERATIONS IN THE DECCAN AND KONKAN.

Nos. 10 & 11 PARTIES.


KHANDESH
NIZAMS DOMINIONS
BERAR
BOMBAY
REFERENCES
Sheets Published
Surveyed during previous Seasons
Do. 1884-85 on Scale 2"=1 Mile
Do. " 1884-85 on Scale 4"=1 Mile
Triangulated in advance
Triangulated & Traversed in advance
Mapped from old Survey of the Nizam's Dominions
NOTES
The numerals 191 &c. indicate the Standard Sheets on the Scale of 1"=1 Mile
The figures and lines in circles represent the numbers and limits of the Engraved Sheets of the Atlas of India
Scale of Miles
District boundary
Do. name NASIK
Taluka boundary
Do. name KHED

REFERENCES

New Numbers on Index	Old Numbers on Sheets	New Numbers on Index	Old Numbers on Sheets
191	4	227	49
159	4*	225	50
133	4**	245	50*
225	5	226	51
257	6	286	52
160	7	268	53
134	7*	296	54
192	8	324	55
226	9	346	56
258	10	295	57
193	11	237	58
227	12	269	59
259	13	293	60
194	14	325	61
228	15	347	62
260	16	355	62*
290	17	204	63
195	18	238	64
229	19	270	65
261	20	300	66
291	21	326	67
317	21*	348	68
196	22	326	68*
230	23	172	69
262	24	171	70
292	25	170	71
318	25*	169	72
197	26	168	73
231	27	167	74
263	28	141	74*
293	29	166	75
319	29*	165	76
198	30	164	77
232	31	163	78
264	32	162	79
294	33	161	80
320	34	135	81
199	35	136	82
233	36	137	83
265	37	138	84
295	38	139	85
321	39	140	86
343	39*	178	87
200	40	205	88
234	41	239	89
266	42	271	90
296	43	174	94
322	44	206	95
344	45	240	96
201	46	242	115
235	47	275	116
267	48	276	122

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Published under the direction of Colonel G. C. De Pree, R. C., Surveyor General of India.

Survey of India Office, Calcutta, March

1886

61. Extracts from Colonel Pullan's Narrative Report will be found at page xxiv of the Appendix and the cost rates at page 62 Part II.*

SOUTH DECCAN, BOMBAY PRESIDENCY.

(No. 11 Party, Revenue Branch.)

62. This party, of the strength as per margin, left recess quarters at Poona on 1st November 1884, and proceeded to the northern part of the Ratnágiri District between 17° and 18° North Latitude, where field operations were resumed. The programme of field work was mostly completed by the end of May 1885, when the main establishment returned to quarters, but some of the surveyors remained out till driven in by the rains in June.

Personnel.

Major D. C. Andrew, Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. J. T. U. Coxen, Surveyor, 4th grade.
Mr. J. Hickie, Assistant Surveyor, 1st grade.
Mr. P. White, " " "
Mr. G. A. Knight, " " 2nd grade, transferred on 1st June 1885.
Mr. A. George, Assistant Surveyor, 3rd grade, joined on 19th June 1885.
Mr. C. Tapsell, Assistant Surveyor, 1st grade, attached for 3 months during recess.
20 Sub-Surveyors, and others.

63. The tract of country surveyed during this field season consisted of portions of the Sátára, Ratnágiri, and Kolába Districts and of the Kolhápur and Southern Mahratha Agency. The topographical out-turn is 1,662 square miles on the 2″ scale; an area of 2,467 square miles was triangulated, and 1,108 linear miles of traverse work was executed. The completed area is comprised in sheets 171, 170, 169 and in parts of sheets 203, 204, and 239. The area of preliminary triangulation in advance for next season is 2,745 square miles, and that of traversing is 1,138 square miles.

64. The system of survey has been continued as before; all the features of the country, as far as the scale admitted, were fully surveyed. The village boundaries have been obtained by direct survey and afterwards compared with the Bombay Revenue Survey maps, and those of the forests also where demarcated. The country surveyed is stated to consist chiefly of intricate hilly ground intersected by numerous creeks and water-courses, and much difficulty was experienced from want of sweet water and from the haziness of the atmosphere during and after March, caused by the burning of jungle.

65. Additional traversing beyond that which would be required for a purely topographical survey, was carried out as usual in this party, with the object of furnishing the local Revenue Survey Department with the numerical data of the co-ordinates of all the village trijunctions and of the necessary intermediate stations which have been selected as far as possible on the permanently marked trijunctions of fields, so that a scientific framework will be available in the event of any future large scale surveys being required for settlement purposes.

66. The survey of the town of Pandharpur, on the large scale of 80 inches=1 mile, consisting of 21 original field sheets, may be considered as finished. During the year under report, the survey of the last 2 sheets was completed and 7 sheets were examined in the field, all of which are shortly expected in Calcutta for reproduction by photo-zincography. The entire expense of this survey has been met by the Municipality of Pandharpur.

67. The number of heights fixed by the triangulation is 753, giving an average of 1 to about 4 square miles; numerous clinometrical heights have also been taken by the detail surveyors. The accuracy of the topography was tested by 104 miles of check traverse in the open and more level parts of the country, and in mountainous ground the field plans were examined *in situ* at 138 stations, and the executive officer states that no revisions were found necessary.

68. During the recess, fair maps of sheets 171, 170, 169 on the 2-inch scale have been prepared for publication, each in 4 sections, and 5 sections of sheets 203 and 239 have also been drawn. The reduction to the scale of the Atlas of India has been prepared of all the above sections. Two triangulation charts and an index chart of the traverses have also been projected.

* Colonel Pullan reports favorably of his assistants, making special mention of Messrs. Gwynne and Fielding and K. N. Gupchup, the Head Writer.

69. During the current season the topographical operations will be continued in sheets 172, 168, 173 and portions of 204 and 205, while the preliminary triangulation will be extended over sheets 206, 175, 207, and 208.*

GUJARAT SURVEY.

70. The office of the party was inspected by the Surveyor General on the 18th of November, and by the 20th all the members had left Poona. They re-assembled in recess quarters again at the end of May 1885.

Personnel.

Lt.-Colonel W. F. Badgley, S.C., Officiating Deputy Superintendent, 2nd grade, in charge.
Lieutenant G. B. Hodgson, S.C., Officiating Assistant Superintendent, 1st grade, transferred 30th September 1885.
Mr. A. Christie, Surveyor, 3rd grade, transferred.
„ C. H. McAfee, „ 4th „ „
„ C. Tapsell, Asst. „ 1st „ „
„ S. Norman, „ „ 2nd „
„ C. Norman, „ „ 2nd „
„ A. George, „ „ 3rd „ transferred.
„ P. J. Serrao, „ „ 3rd „

Sub-Surveyors.

Gopal Vishnu, Govind Gopal,
Bhau Govind, and 26 others, of whom 4 have been transferred and 2 discharged.

Joined during the Recess.

Mr. J. Newland, Surveyor, 4th grade.
„ G. A. Knight, Asst. „ 1st „

Excepting about 22 square miles on the 4″ scale the work was all on the scale of 2 inches to 1 mile. In the two mahals which form a plateau about 950 feet above sea, the country was open and easy, while in other places, it was broken, wooded, and difficult. Carriage and food were procurable everywhere, and the climate was dry and but moderately hot in the winter months, so that taking all together the work should have progressed favourably, but late rains had so increased the natural unhealthiness of the country that during the field season no less than 568 days of work, out of a total 3,878, were lost through sickness, and many cases of ague have occurred among the sub-surveyors during the recess.

71. The total out-turn of the field season was as follows:—2,162 square miles of triangulation which, with the balance over from other years, gives about 4,480 square miles in advance of topography; 445 linear miles of traverses, for the most part of State boundaries, and 1,711 square miles of detail survey on the 2″ scale and 22 square miles on the 4″ scale, which last completes the survey on that scale.

72. The total area of finished survey in Gujarát is now 19,839 square miles, the survey of which was begun in 1859, and there remain unfinished about 10,050 square miles, which will probably occupy the party for another five years. The account with Baroda for the year is 428 square miles (part surveyed during the year and part to credit from former years) for which Baroda will pay R4,280. Nearly all the Baroda State has now been surveyed, and of what remains about 500 square miles will be done in the coming field season.

73. As a quantity of mapping remained over from last year and more came in for examination during the field season, some sub-surveyors were employed in mapping throughout, and the results for the entire year are as follow:—

On the 4″ scale twenty-five sections have been finished and five nearly completed, and on the 2″ scale ten sections have been finished and three are in progress. The triangulation charts for the General Reports of Degree Sheets III and IV have been finished and the charts of the season's triangulation well advanced. In recess two Degree Sheet Reports have been finished also, besides the computations for the year, which have shown very good results.

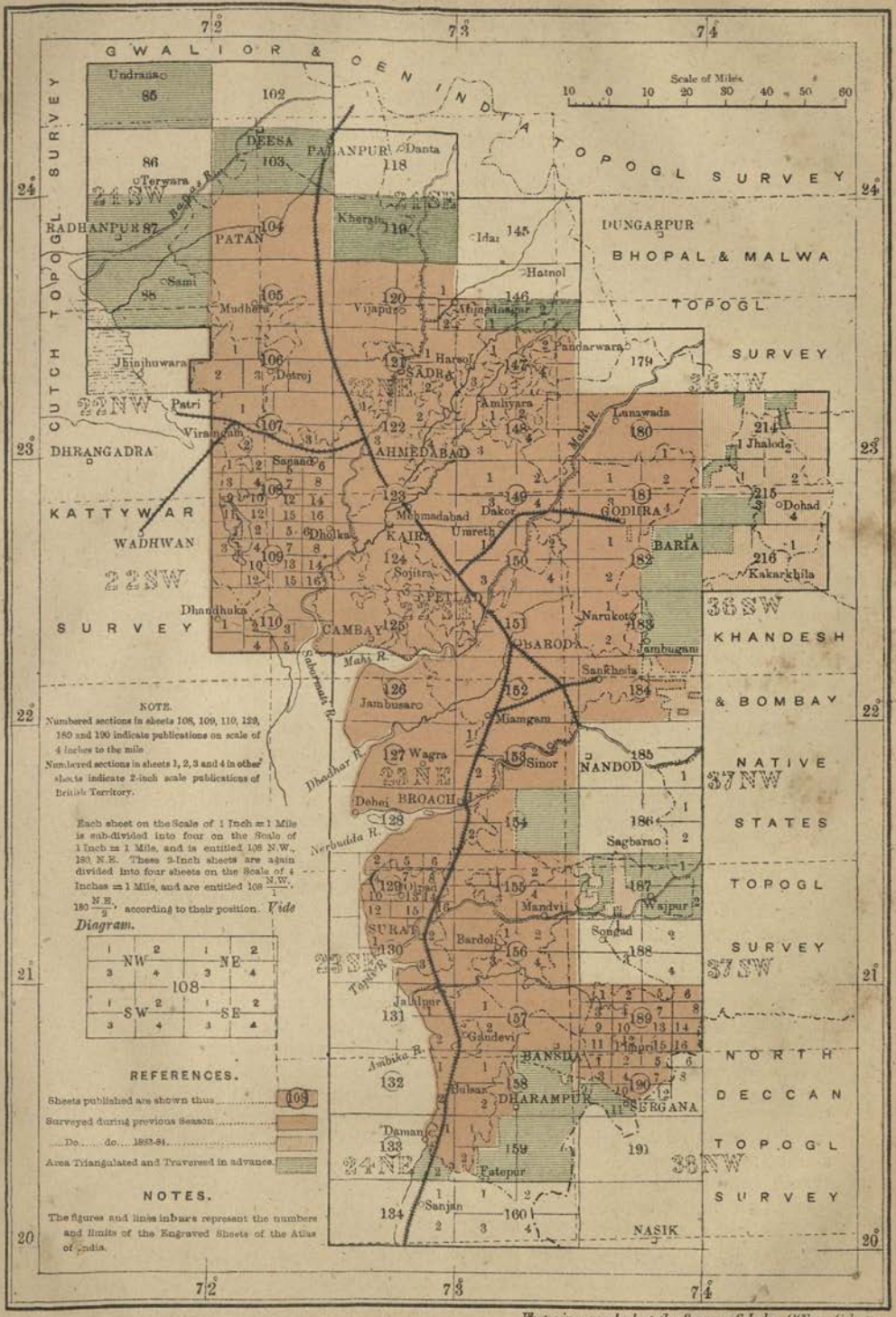
74. During the following field season it is proposed to do no triangulation. The survey, on the scale of 200 feet to one inch, of the city of Baroda (which has been already begun and for which the Baroda Government will pay), the detail survey of sheets 87 and 119 on the 2″ scale, and the completion of the Dohad and Jhálod maps, in which some gaps were left owing to sickness last season, will be taken up.

75. For extracts from Colonel Badgley's Narrative Report see page xxiv of the Appendix, and for cost rates page 62 Part II.†

* Major Andrew reports that, with one exception, he is exceedingly pleased with the work done by all his assistants, and especially brings to notice the zealous aid of Mr. J. Hickie. The sub-surveyors are said to have shown a marked improvement in their work, both in the field and in office.

† Colonel Badgley reports of his assistants that he is "much obliged to all the members of the party for good and steady work."

INDEX TO THE SHEETS OF THE GUJARAT SURVEY



NOTE.

Numbered sections in sheets 108, 109, 110, 129, 160 and 190 indicate publications on scale of 4 inches to the mile

Numbered sections in sheets 1, 2, 3 and 4 in other sheets indicate 2-inch scale publications of British Territory.

Each sheet on the Scale of 1 Inch = 1 Mile is sub-divided into four on the Scale of 1 Inch = 1 Mile, and is entitled 108 N.W., 180 N.E. These 2-Inch sheets are again divided into four sheets on the Scale of 4 Inches = 1 Mile, and are entitled $108\frac{N.W.}{2}$, $180\frac{N.E.}{2}$, according to their position. *Vide Diagram.*

REFERENCES.

Sheets published are shown thus 109

Surveyed during previous Season .....

.....Do.....do.....1883-84.....

Area Triangulated and Traversed in advance.

NOTES.

The figures and lines in bare represent the numbers and limits of the Engraved Sheets of the Atlas of India.

Photozincographed at the Survey of India Offices, Calcutta

Published under the direction of Colonel G. C. De Prée, S.C., *Surveyor General of India.*

Survey of India Offices, Calcutta, March

1886.

THÁNA AND KOLÁBA DISTRICTS, KONKAN, BOMBAY PRESIDENCY.

(No. 10 Party, Revenue Branch.)

76. The field operations of this party were conducted by Major Hill, R.E., who remained in charge until 5th July 1885, when he was required to superintend the tidal and levelling operations, and Lieutenant Longe, R.E., has been in executive charge since that date.

Personnel.

Major J. Hill, R.E., Deputy Superintendent, 3rd grade, in charge up to 5th July 1885.
Lieutenant F. B. Longe, R.E., Officiating Deputy Superintendent, 4th grade, in charge from 6th July 1885.
Mr. A. M. Lawson, Surveyor, 2nd grade.
Mr. J. Newland, ditto 4th ditto.
Mr. W. M. Kelly, Assistant Surveyor, 1st grade.
Mr. R. R. Dickenson, ditto 1st ditto.
20 Sub-Surveyors and others.

Field work was commenced on 28th November 1884 and closed on 28th May 1885. The survey of the portions of the Konkan allotted to this party has been brought to a successful conclusion during the season under review, and a commencement has been made of the topographical survey of the Southern Marátha country, the sanction for which is contained in letter No. $\frac{522 \text{ S.}}{129\text{-}6}$, dated 18th September 1884, from the Secretary to the Government of India, Revenue and Agricultural Department, to the address of the Surveyor General. Thus the operations of the party were carried on in three parts of the Bombay Presidency: in the north, the 4 inch scale survey of the Thána District which was undertaken to meet the requirements of the Forest Department, and the 2 inch survey of the Native State of Jawhár, have been completed; in the Kolába District, which lies below the Ghâts to the south of Bombay, standard sheet 167 was surveyed on the 2 inch scale; and in the southern portion of the Presidency, the preliminary operations of triangulation and traversing were commenced in the neighbourhood of Belgaum for the new survey of the Southern Marátha country. The index map will be found at page 21.

77. The area topographically surveyed amounts to 483 square miles on the 4 inch scale and 566 square miles on the 2 inch scale. The traverse work in the above area aggregated 519 linear miles and fixed 261 village trijunction marks. The stations have been fixed on stones with a special mark cut on them. In addition to the above, preparatory triangulation and traversing for the detail survey next season have been executed over an area of 758 square miles, while triangulation alone has been extended over a further area of 492 square miles. The traverse survey has fixed 1,644 points, of which 552 are trijunctions of village boundaries.

78. The heights of 288 useful points have been determined trigonometrically and their values verified by connection with the bench marks of the tidal and levelling party. All the features of the country were surveyed as closely as the scales admitted, and the accuracy of the topography was tested by about 80 linear miles of check survey over the more level parts of the country, and in the hilly portions the plans were carefully examined *in situ* by the executive officer and the European assistants.

79. The country surveyed is similar in character to that in which the party was employed during the preceding season. In Kolába the ground was all hilly and difficult, and in Thána also it was very hilly and intricate, the only open part being that lying between the Bombay, Baroda and Central India Railway and the Sea. No towns of importance were included within the season's operations; but in Thána, the village of Sanján, on the right bank of the Varoli river and 4 miles east of Umbargaon, is interesting, as being the place where the first Parsi emigrants landed about the year 716 A.D., and placed themselves under the protection of Jadi Rana, the Chief of Sanján. A further description of the country will be found in the appendix to this report.

80. As usual, the portion of the establishment working in the Thána District suffered much in health. One sub-surveyor, Nathu Lall, died and many of the measurers were invalided, some of whom have since succumbed to the effects of the fever contracted during the field season. Elsewhere the health of the party was good.

81. During the recess, the mapping of the 4 inch scale survey was prepared for reproduction for the use of the Forest Department and consisted of 23 sections of the standard size, comprised within sheets Nos. 160, 134, 159, 133. The drawing of the native surveyors is gradually improving, though their style is still coarse, and a large proportion, nearly 79 per cent., of the original field plans was found to be fit for reproduction by photo-zincography, so that a very small amount of redrawing to complete the above sheets was necessitated in office. Of the maps on the 2 inch scale for reduction to 1 inch, the following have been drawn during the recess:—

4	Sections	of	sheet	No. 167.
2	,	„	„	141.
4	,	„	„	161.
4	„	„	„	135.

The final charts of the triangulation and traversing of the Thána District have also been completed and submitted to Head-quarters, and in addition 72 skeleton maps on the 4 inch scale, showing village boundaries and traverse stations, together with the data connected therewith, have been prepared for the Settlement Department.

82. The Survey of the Thána District has now been completed and the future work of the party is to make a topographical survey on the 2 inch scale of that part of the Bombay Presidency which lies to the south of the parallel of 16° N. Latitude. In connection therewith, the Bombay Government have applied for the services of this party to make a trigonometrical and traverse survey on the scale of 8 inches to a mile of all the important forests of the Southern Marátha country and Kánara to serve as a basis for the preparation of correct working plans. The Bombay Government have been informed that the Survey Department is prepared to undertake this work, provided the full cost of the operations is borne by them, and on this supposition the preliminaries of the forest surveys have been commenced.*

MALWA SURVEY.

83. The field work of this party was started by Major Carter from Rutlám, where the Field Depôt was established early in November 1884. On the 24th that officer proceeded on furlough making over charge of the Party to Mr. Patterson, who superintended the Field operations till the return of the Party to recess quarters towards the end of April 1885, and the recess work till 26th October, when he was transferred to the Mirzapur Party and handed over this Party to Mr. G. H. Cooke, Deputy Superintendent, 4th grade, after having made all the arrangements necessary on the transfer of the Party to traverse work in Jubbulpore.

Personnel.

Major T. T. Carter, R.E., Deputy Superintendent, 1st grade, in charge to 24th November 1884.
Mr. W. H. Patterson, Officiating Deputy Superintendent, 4th grade, in charge from 25th November 1884.
Mr. J. A. May, Surveyor, 1st grade.
Mr. G. Vander Beck, Assistant Surveyor, 1st grade.
Mr. C. George, „ 2nd grade.
Mr. J. A. Higgs, „ 2nd grade.

Sub-Surveyors.

Shekh Oomar, Hyder Ally,
Mr. F. Rosario, Bapu Jadu, and 5 others.

84. The country surveyed this year includes portions of the Dúngarpur and Oodeypore States of Rajputana and a small area of the Idar State forming part of the Mahikántha Agency in the Bombay Presidency.

85. The out-turn of work during the season consisted of a detail survey on the 1″ scale of 1,157 square miles in Standard Sheets 58 and 59; 6 square miles of the City of Dúngarpur on the 6″ scale, and 4 square miles of the Cantonment of Kherwára on the 12″ scale.

* Major Hill reports as follows on the assistants of his party:—

"Mr. Lawson conducted his duties most efficiently, and, as in all former seasons, has worked to my complete satisfaction. It is with great pleasure that I again place on record my appreciation of his valuable services.

"Mr. Newland has performed his duties most satisfactorily. I regret that he has been transferred from this party, in which he has done so much good work, and in which he has secured the regard both of myself and the other members of the party.

"Mr. Kelly had exceptionally responsible duties confided to him . . . . He has shown himself to be a capable officer and has worked most energetically.

"Mr. Dickenson has worked very well both in the field and in office.

"The sub-surveyors have all worked well, although in some cases sickness prevented their out-turn from being large."

No. 2 PARTY.

INDEX TO THE SHEETS OF THE BHOPAL & MALWA TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch = 1 Mile.

To accompany Surveyor General's Report, 1884-85

Nº 1 TOPOGRAPHICAL SURVEY, GWALIOR & CENTRAL INDIA
BOMBAY PRESIDENCY
GUZERAT TOPOGRAPHICAL SURVEY
KHANDESH & BOMBAY NATIVE STATES TOPOGRAPHICAL SURVEY
CENTRAL PROVINCES
BERAR
HYDERABAD
REFERENCES.
Sheets published.
Surveyed during previous Seasons on Scale of 1 Inch = 1 Mile.
Surveyed during 1884-85 on Scale of 1 Inch = 1 Mile.
Cities Surveyed on large Scales, names underlined as
INDORE
NOTES.
The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India.
Triangulation Chart, Degree Sheets are numbered thus
IV
Scale 1 Inch = 32 Miles.
30 Miles

Published under the direction of Colonel G. C. Depree, R.E., Surveyor General of India,
at the Survey of India Offices, Calcutta, January 1886.

86. The triangulation and traversing for the large scale surveys were completed, this being the only triangulation executed during the season, and a traverse survey of some disputed boundary between the States of Dúngarpur and Idar was made at the request of the respective States. The triangulation for the Kherwára Cantonment Survey was executed by Sub-Surveyor Shekh Oomar; the stations have been marked by the usual circle and dot on stones, which have been sunk flush with the ground.

87. The country plane-tabled is for the most part very intricate, hilly, and covered with much jungle; in parts, especially along the western limits of the work in Sheet 58 where the hills rise to an altitude of some 1,600 to 1,800 feet, the view presented is a wild, confused mass of hills stretching as far as the eye can see. A main road passes from Rutlám *viá* Bánswára and Dúngarpur to Kherwára where it divides, one branch going to Ahmedabad and another to Oodeypore; it is passable for wheeled conveyance.

88. Standard sheets 58 and 59 have been mapped during the recess and large scale plans of the City of Dúngarpur and of the Cantonment of Kherwára have been prepared; also a Triangulation Chart of Degree Sheet XIV of Malwa. Triangulation Charts of Degree Sheets III and VI of Khandesh are also very near completion.

89. The report for Degree Sheet XIV of Malwa has been completed and that for Degree Sheet VIII of Khándesh has been examined and the volumes bound; very little remains for completion. The reports for Degree Sheets III, VI, and IX of Khándesh have been advanced a good deal, but there is still some extracting and examination to be done, which will be taken in hand next year.

90. The routes connecting the two Presidencies of Bengal and Bombay, passing through Sheets 50, 52, 54, 58, and 59, have been compiled and forwarded for the Quartermaster General's Departments of the respective Presidencies.

91. The area made over for Survey to the Malwa Party having been completed during the season under report, the Survey has been transformed into a Revenue party for traverse survey in Jubbulpore, under the superintendence of the Deputy Surveyor General, Revenue Branch.

92. The Bhopal and Malwa Topographical Survey, during the past 15 seasons, has completed an area, on the 1″ scale, of 29,262 square miles comprised in 59 standard sheets. In addition, large scale surveys have been made and mapped of 13 Cities and Cantonments representing an aggregate area of 127 square miles. To date 57 standard sheets and 11 City and Cantonment plans have been published, those remaining for publication forming the current season's work.

93. The survey of this district was commenced in 1870-71 by Major Riddell, R.E., and carried on by that officer till 1873-74, when the charge of the party devolved on Lieutenant-Colonel Wilmer by whom the work was continued till 1882-83, when the Party was transferred to Mirzapur. The late Khándesh Party (afterwards named the Malwa) under Major Carter, R.E., then resumed this work and did a full season's area in 1883-84, and in the following season the charge of the Survey was held by Mr. Patterson by whom the work has now been completed.

94. The above area is situated within the parallels of $\frac{22°-15'}{24-00}$ North Latitude and the meridians $\frac{73°-30'}{79-00}$ East Longitude, and comprises the following Native States—Bhopal, Holkar, Sindhia, Narsinghgarh, Jaora, Jhábua, Dhár, Pártábgarh, Bánswára, Rutlám, Dúngarpur and a small portion of Oodeypore, all of the Bengal Presidency; also small areas of the Mahikántha and Rewákántha Agencies of the Bombay Presidency.

95. Mr. Patterson brings to notice the very cordial aid rendered by the Political Officers to the Survey establishment during the season under report, and particularly mentions the hearty co-operation of His Highness the Maharawal of Dúngarpur, who rendered great assistance to the Survey Staff. As the work was carried on in the midst of some of the most important clans of the Bheels, who are massed on the borders of the States, and who, being very independent and little influenced by the different durbars, are inclined to be troublesome and obstructive, great care and tact were required to avoid a disturbance and to enable the survey to progress.

96. Mr. Patterson says that the health of his party was on the whole good;

some cases of fever had to be attended to, but the native establishment kept their health throughout the season.

97. For a description of the country, see p. xii of the Appendix to the General Report for 1883-84, and for cost rates of this season's work p. 62 Part II.*

MIRZAPUR SURVEY.

98. This party surveys topographically on the 2 inch scale those portions of the Mirzapur District that Colonel Anderson's Revenue Survey Party was unable to do. They consist of very hilly, broken, and jungly country, chiefly, situated south of and including the Kaimúr Range between latitude $\frac{25° 45'}{24° 45'}$ and longitude $\frac{82° 15'}{83° 30'}$. The party is also occupied in running theodolite traverses round the villages in Dúdhi pargana for revenue purposes on the scale of 16 inches=1 mile. The pargana of Bhadohi and the rest of the estates of the Benares Raja will also be similarly surveyed.

Personnel.

Lieutenant-Colonel J. R. Wilmer, S.C., Officiating Deputy Superintendent, 3rd grade, in charge until 30th September.
Mr. W. H. Patterson, Officiating Deputy Superintendent, 4th grade, in charge from 1st November.
Mr. C. F. Hamer, Surveyor, 4th grade.
„ E. A. Wainright, Assistant Surveyor, 1st grade.
„ H. T. Kitchen, Assistant Surveyor, 1st grade.
„ W. H. Lilley, ditto ditto.
„ R. F. Warwick, ditto 2nd grade.

Sub-Surveyors.

Azim Khan, Prem Raj, | Kisto Dhon Chatterjee, and 14 others.

Mr. Patterson was transferred to the Bhopal and Malwa Survey in November 1884.
Mr. Wainright was transferred to the Baluchistan Party in June 1885.
Mr. Pocock was transferred to this Party from the Mysore Survey in June 1885.
Mr. Potter was transferred from the Coast Survey Party to this Party in June 1885.
Two student soldiers, Lal Sing, 19th Bengal Cavalry, and Bhoop Sing, 28th Punjab Infantry, were sent to learn survey work, and joined in November at Chunar.
One Sub-Surveyor was transferred to the Baluchistan Party and one entertained.

99. The area surveyed in detail on the 2 inch scale was 543·2 square miles of portions of the Dúdhi and Agori parganas of the Mirzapur district, and 441 miles of boundary traverses were run. The whole country was covered more or less with forest jungle, especially near the rivers' banks where the ground was very intricate and much broken up.

100. There was no regular triangulation done this season, only a few points being fixed for checking traverses. This was due to 800 square miles of triangulation laid out in advance remaining over at the close of the previous field season.

101. The detail field plans were rigorously tested *in situ*, either by Colonel Wilmer or by one of his assistants, and found to be correct.

102. As in the previous season, two native military students were attached to the party for instruction in surveying. After a two-months' course under experienced European Surveyors they were put on independent topographical work on the 2 inch scale, of which they turned out between them 55 square miles. Colonel Wilmer reports that these students "have shewn themselves to be intelligent men, and evidently very anxious to learn survey work. During the recess they have been employed in tracing, practising hill shading, and plan drawing, and both have considerably improved in drawing."

103. The country surveyed was in continuation of last season's work and was of much the same nature, though perhaps more hilly and uninhabited. The Son, Rihand, and Kanhar were the only rivers of importance met. The former has a sandy bed varying from three-quarters of a mile to one mile in breadth. In some places the sand is treacherous, and the river is fordable by loaded camels only in a few places: there are however ferries, the principal one being at Chopan, between Dúdhi and Robertsganj. The beds of the Rihand and Kanhar rivers are very rocky, and contain running water throughout the year; the former is used for floating timber, bamboos, &c., down to the Son.

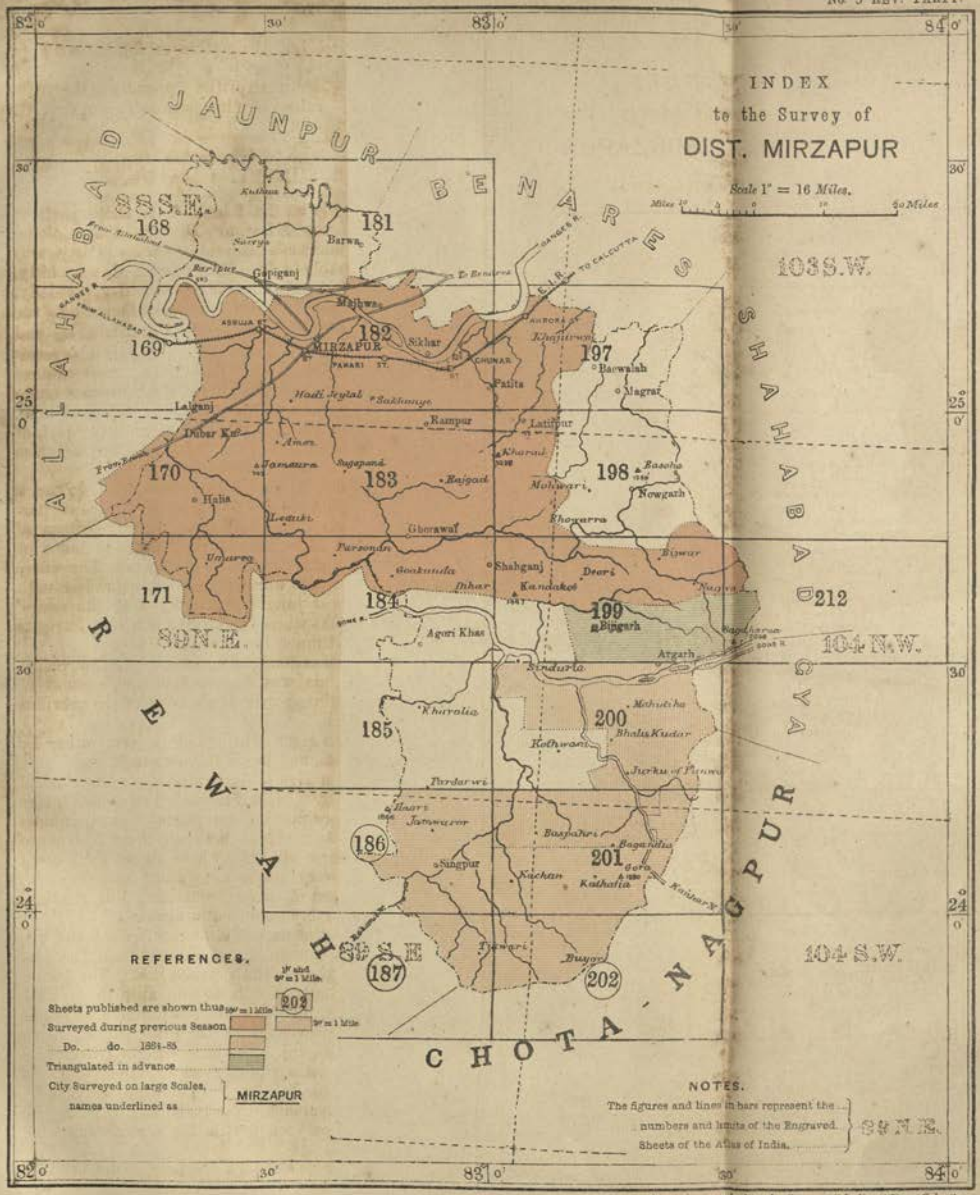
104. During the recess the following standard sheets Nos. 201 N. E., N. W., S. W. and 200 N. E. and S. E. have been drawn for reproduction, and sheets 201 N. E. and S. W. for reduction.

105. The triangulation chart of Degree sheet IX has been completed with

* Mr. Patterson notices the good work done by Messrs. May, Vander Beck, George, and Higgs. He also makes special mention of the services of Sub-Surveyor Sheikh Gomar; Sub-Surveyors Rosario, Bapu Jadu, and Haider Ally also obtain favourable mention.

N. W. PROVINCES SURVEY.

No. 5 REV. PARTY.



Photolithographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S. C., Surveyor General of India.

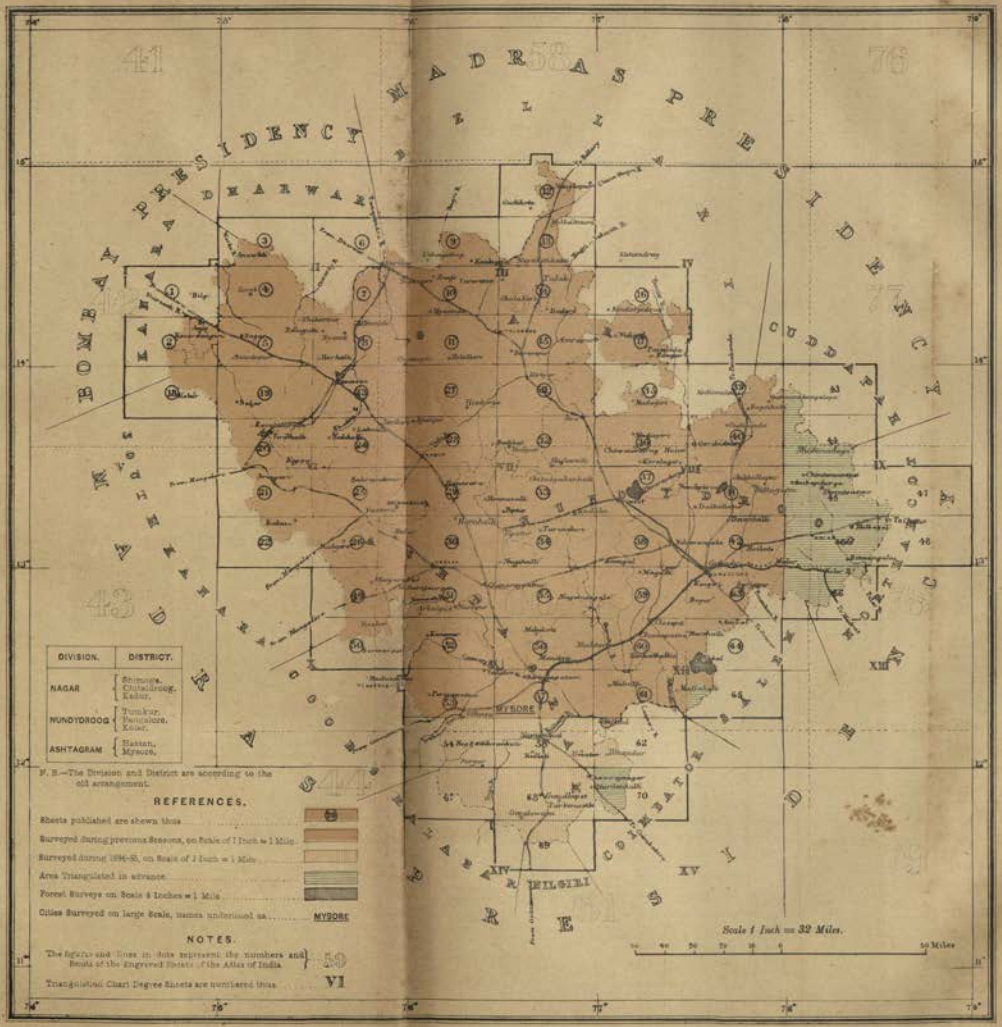
Survey of India Offices, Calcutta, March 1886

No. 8 TOPOGRAPHICAL PARTY.

INDEX TO THE SHEETS OF THE MYSORE TOPOGRAPHICAL SURVEY,

To accompany Surveyor General's Report for 1884-85

On the Scale of 1 Inch = 1 Mile.



DIVISION.	DISTRICT.
NAGAR	Shimoga. Chitaldroog. Kadur.
NUNDYDROOG	Tumkur. Bangalore. Kolar.
ASHTAGRAM	Hassan. Mysore.

N. B.—The Division and District are according to the old arrangement.

REFERENCES.

Sheets published are shown thus

Surveyed during previous Seasons, on Scale of 1 Inch = 1 Mile

Surveyed during 1884-85, on Scale of 1 Inch = 1 Mile

Area Triangulated in advance

Forest Surveys on Scale 4 Inches = 1 Mile

Cities Surveyed on large Scale, names underlined as MYSORE

NOTES.

The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India 58

Triangulation Chart Degree Sheets are numbered thus VI

Published under the direction of Colonel G. C. DePree, R.C., Surveyor General of India,
at the Survey of India Offices, Calcutta, January 1885.

the points obtained from the Bhopal and Malwa Survey, but it is so crowded with stations that the necessary data, *viz.*, latitudes, longitudes, and azimuths, could not be put in. The chart will therefore have to be redone and an attempt made to enter all data required by re-arrangement of the names of points, stations, &c., though it is feared that owing to the number of these more than half will have to be left out or entered in a list of references on the body of the chart. Sheets 201 N. W. and 200 S. E. and N. E. also remain to be drawn on the 2 inch scale for reduction. Sheet 200 N. W. has been drawn as far as surveyed up to date.

106. In the Revenue Branch Mr. C. F. Hamer, Surveyor, 4th grade, was in charge of the 16 inch scale work and he had ten Sub-Surveyors under him who were employed in traversing, setting up, computing, and other work appertaining thereto.

107. The programme for the ensuing season, which has been approved of, is to survey on the 2 inch scale (*vide* Index attached) standard sheets 200 S.W., 185 N.E. and S.E., 184 S.E. and to complete 200 N.W., also to traverse with the theodolite all villages of the Bhadohi pargana of the Mirzapur district to allow of the village maps on the 16 inch scale being reduced by the pentagraph to the 2 inch scale. These village maps are at present in the possession of the Deputy Superintendent of the Raja of Benares' Family Domains.

108. The total cost of survey on the 2 inch scale was R38,486; this does not, however, include the traverse survey of Dúdhi pargana which amounted to R18,433. The cost rates of the 2 inch detail survey and of the traverse measurements will be found at page 62 Part II.*

MYSORE SURVEY.

109. The party took the field in the early part of November 1884 to continue the topography of the Mysore State on the scale of 1 inch = 1 mile, and to complete the survey of the cantonment and city of Bangalore on the scale of 12 inches = 1 mile, and returned to recess quarters towards the end of April, but the field-work of the town survey continued till 1st June.

Personnel.

Major J. R. McCullagh, R.E., Officiating Deputy Superintendent, 3rd grade, in charge.
Lieutenant H. M. Jackson, R.E., Assistant Superintendent, 1st grade, transferred from 24th April 1885.
Mr. L. J. Pocock, Surveyor, 3rd grade, transferred from 16th July 1885.

Surveyors, 4th grade.

Mr. A. J. James, | Mr. F. Kitchen, | Mr. H. Todd,
Mr. J. A. Barker, Assistant Surveyor, 1st grade, joined 5th November 1884.
Mr. R. Todd, Assistant Surveyor, 1st grade, joined 3rd October 1884.
Mr. J. M. Kennedy, Assistant Surveyor, 2nd grade.
„ T. J. J. Mills, ditto, 3rd grade, joined 8th October 1884,
and 10 Sub-Surveyors.

110. The season's triangulation extended over an area of 900 square miles in the Kolar District, and therewith this part of the operations came to an end for the entire province.

111. Additional traversing with the theodolite, to the extent of 24·2 miles, was carried out as a basis for the detail survey of Bangalore, and lines of spirit levels, covering 64·5 linear miles, were run, by which a large number of bench-marks were permanently fixed, besides numerous ones of a temporary nature to facilitate the contouring of the large scale map.

112. The final topography on the 1″ scale covers an area of 2,365 square miles in the Mysore District, which, if not quite so large an out-turn as has been accomplished in some previous years, was as much as the extremely difficult nature of the country and the unhealthiness of the season would admit of. The survey was close and minute, the average number of plane table fixings being 11·8 per square mile, while over a very large extent of country the detail was got in almost entirely by chain measurements, and it underwent a searching examination by 183 miles of check-line as well as by testing *in situ*. The Bangalore survey was nearly altogether done by plane table and chain, based on the triangulation and theodolite traverses, and comprises an area of 33 square miles.

113. As usual this survey has contributed to the training of young officers, and Lieutenant H. M. Jackson, R.E., has, after two field seasons, with this party, been passed as an experienced topographer.

* Colonel Wilmer speaks favourably of all his assistants, specially commending Mr. Hamer.

114. The operations of the season were cast in what was certainly one of the most difficult parts of the province the party has yet had to encounter from a survey point of view, a full half of the area consisting of interminable forest and jungle, very sparsely populated, even where villages existed at all. The most ordinary supplies of food were scanty and had to be procured from long distances, while even water was difficult to obtain. The heat was intense, severe and continuous physical exertion had to be maintained, the detachments were constantly molested by wild elephants and other beasts, and to crown all, the season proved very unhealthy, which resulted in the complete prostration of several members of the party and a large number of the menial establishment.

115. During the recess an unusually large amount of mapping has been completed, comprising standard sheets Nos. 54, 58, 62, 67, 68, and 69, the map of Mysore City in six sheets, the map of Bangalore Cantonment and City in twelve sheets, and a chart of the special triangulation for the Bangalore large scale survey, while six degree charts are in hand and well advanced. All the computations of the season have been brought up and fair progress has been made with the general reports.

116. During the coming season there is every reason to expect that the topography of the entire Mysore Province, comprised in nine sheets remaining to be done, will be successfully accomplished. The survey was commenced in 1875.

117. The cost of this survey is met by the Mysore Government and will be found at page 62 Part II, and extracts from Major McCullagh's Narrative Report on page xxxii of Appendix.*

RAJPUTANA SURVEY.

118. The operations of the party during the year under review were as follow :—

Personnel.

Major R. Beavan, S.C., Deputy Superintendent, 4th grade, in charge.
Lieutenant W. H. Pollen, R.E., Officiating Assistant Superintendent, 1st grade.
Mr. A. J. Wilson, Surveyor, 1st grade.
„ W. J. Cornelius, Asst. Surveyor, 1st grade.
„ G. P. Tate, ditto, 2nd do.
„ M. Gastaud, ditto, 3rd do.
„ P. Beechy, ditto, 3rd do.

Sub-Surveyors.

Abdul Gafur,
Golam Mahomed,
Abdul Aziz, and five others.

(*a*) The completion of the revised survey of Ajmere on the scale of 12 inches to the mile, and the rigorous testing of the work done the previous season. (*b*) The detail survey of the city of Jeypore, including the old city of Amer (Amber) and the surrounding hills, on the scale of 6 inches to the mile. (*c*) The regular detail survey on the 1 inch scale of standard sheets, Nos. 73, 74, 75, all lying in the Jodhpore State and the greater portion of No. 76, containing parts of Sirohee and Pálanpur.

119. The field season lasted from the 3rd November 1884 to the 20th April 1885, and the out-turn of topography on the 1 inch scale was 1,808 square miles. The area surveyed on the 6 inch scale at Jeypore was 77·3 square miles, and the remaining portion of Ajmere surveyed on the 12 inch scale was 5·58 square miles. There was no triangulation carried out except a small extension at Jeypore covering about 3 square miles.

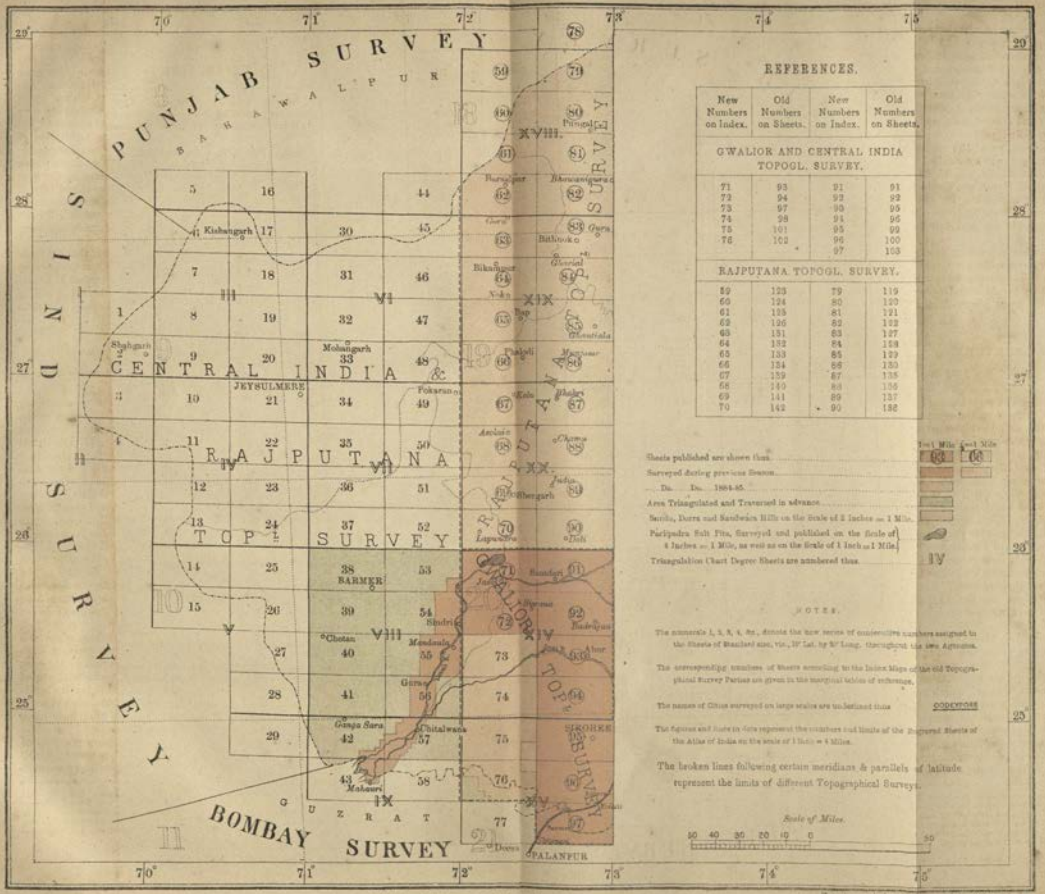
120. The Ajmere survey was completed by the end of December, when the staff there employed moved to Bhínmál and proceeded with the regular 1 inch survey. The country surveyed on the 1 inch scale was open and fairly easy excepting in a few places where the thick jungle necessitated a constant use of the chain. The largest village met with was Bhínmál, which used to be the headquarters of the district, but the *tahsil* has lately been transferred to Jaswantpura. There are some fine tanks at Bhínmál and several old temples and buildings, indicating that it was at some early time a place of importance.

121. It was originally intended to survey the hills and outlying portions of Jeypore city on the 6 inch scale, and the city, gardens, &c., on the scale of 12 inches to a mile; but, with the consent of the Resident and the military author-

* Major McCullagh commends the energy and the perseverance of Lieutenant Jackson, R.E., Assistant Superintendent, under ill-health and trying circumstances; he also reports most favourably of the aid rendered by his assistants; Messrs. Pocock, H. Todd, Barker, Kennedy, and Mills have all done excellent work, while he specially mentions Messrs. James, Kitchen, and R. Todd for their strenuous exertions under great difficulties. The sub-surveyors are now a thoroughly trained body of men and have discharged their duties in a very satisfactory manner, as has also Krishna Rao, the writer and accountant of the party.

CENTRAL INDIA & RAJPUTANA

INDEX TO THE RAJPUTANA SURVEY.



REFERENCES.

New Numbers on Index.	Old Numbers on Sheets.	New Numbers on Index.	Old Numbers on Sheets.
GWALIOR AND CENTRAL INDIA TOPOGL. SURVEY.			
71	93	91	91
72	94	92	92
73	97	93	95
74	98	94	96
75	101	95	99
76	102	96	100
		97	103
RAJPUTANA TOPOGL. SURVEY.			
59	123	79	119
60	124	80	120
61	125	81	121
62	126	82	122
63	131	83	127
64	132	84	128
65	133	85	129
66	134	86	130
67	139	87	135
68	140	88	136
69	141	89	137
70	142	90	138

Sheets published are shown thus ..... 1 Mile 93 — 4 Mile 66

Surveyed during previous Season .....

Do. Do. 1884-85 .....

Area Triangulated and Traversed in advance .....

Sambu, Dorra and Sandwara Hills on the Scale of 2 Inches = 1 Mile.

Paripadra Salt Pits, Surveyed and published on the Scale of 4 Inches = 1 Mile, as well as on the Scale of 1 Inch = 1 Mile.

Triangulation Chart Degree Sheets are numbered thus IV

NOTES.

The numerals 1, 2, 3, 4, &c., denote the new series of consecutive numbers assigned to the Sheets of Standard size, viz., 10' Lat. by 20' Long. throughout the two Agencies.

The corresponding numbers of Sheets according to the Index Maps of the old Topographical Survey Parties are given in the marginal tables of reference.

The names of Cities surveyed on large scales are underlined thus ..... CODEYPORE

The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India on the scale of 1 Inch = 4 Miles.

The broken lines following certain meridians & parallels of latitude represent the limits of different Topographical Surveys.

Scale of Miles.

50 40 30 20 10 0 50

Published under the direction of Colonel G. C. De Prée, R.C., Surveyor General of India.

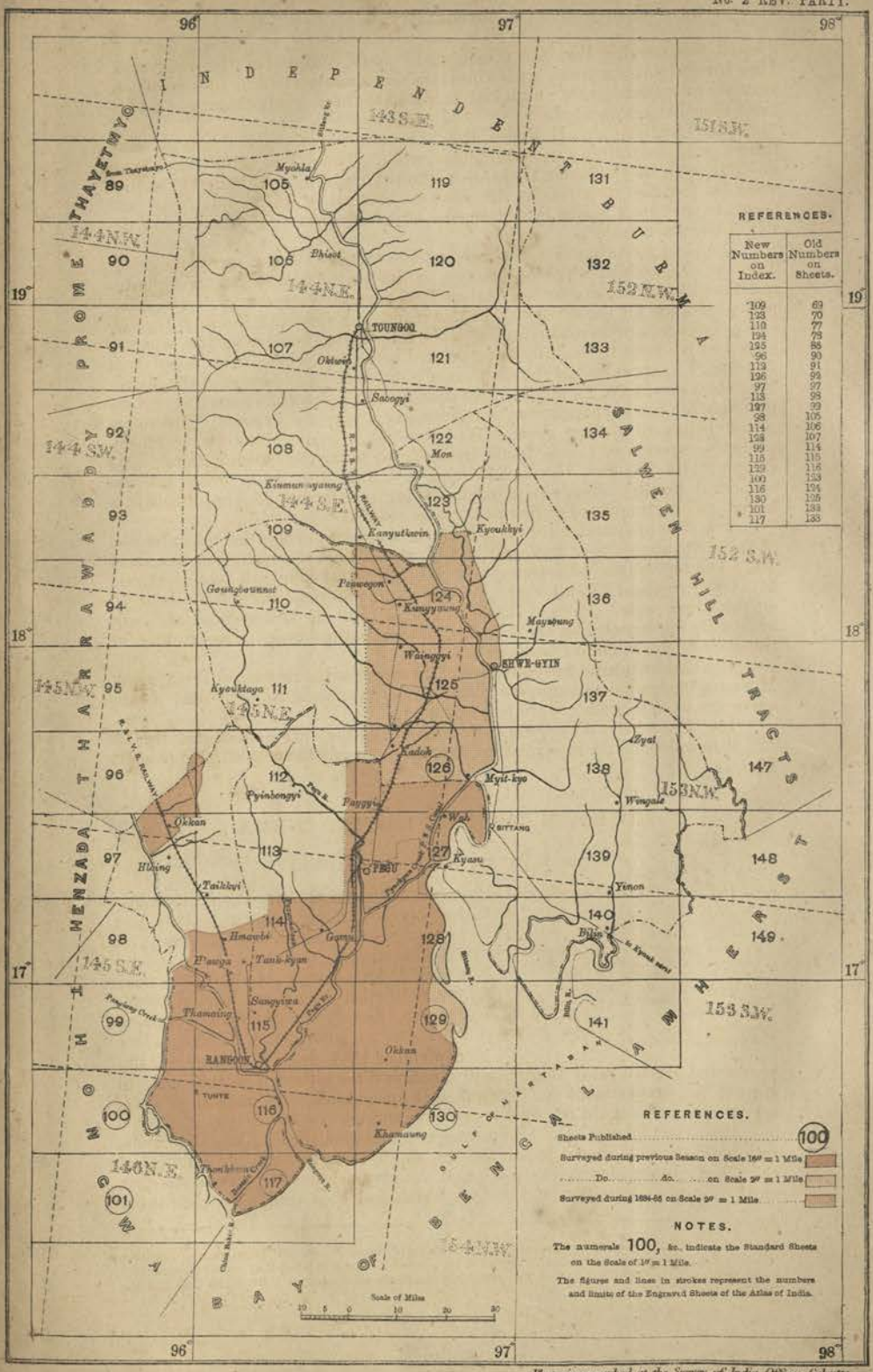
Survey of India Offices, Calcutta, March 1886.

Photozincographed at the Survey of India Offices, Calcutta.

BRITISH BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY OF DISTS. HANTHAWADDY, PEGU, SHWE-GYIN & TOUNGOO.

No. 2 REV. PARTY.



REFERENCES.

New Numbers on Index.	Old Numbers on Sheets.
109	69
123	70
110	77
124	78
125	85
96	90
112	91
126	92
97	97
113	98
127	99
98	105
114	106
128	107
99	114
115	115
129	116
100	123
116	124
130	125
101	133
117	133

REFERENCES.

Sheets Published ..... (100)

Surveyed during previous Season on Scale 16" = 1 Mile

..... Do. ..... do. ..... on Scale 2" = 1 Mile

Surveyed during 1884-85 on Scale 2" = 1 Mile

NOTES.

The numerals 100, &c., indicate the Standard Sheets on the Scale of 1" = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India.

Photozincographed at the Survey of India Offices, Calcutta

Published under the direction of Colonel G. C. De Prée, S.C., *Surveyor General of India.*

Survey of India Offices, Calcutta, February

1886.

ities, it was decided that the 6 inch scale would suffice for the whole area. This survey was executed with considerable minuteness of detail, as the old survey was comparatively rough and there have been great changes and additions since it was executed.

122. Lieutenant W. H. Pollen, R.E., Assistant Superintendent, was attached to this party for training in topographical work. Two military students, Sowars Jowala Singh of the Guide Corps, and Bhugwan Singh, 2nd Punjab Cavalry, were temporarily attached for the same object: all of them did useful and accurate work, and Major Beavan reports that they thoroughly understand the use of the plane table.

123. During the recess 2 sheets of the Ajmere survey were completed. There are 7 sheets, of which 5 were sent in, during the field season, to the headquarters office for reproduction, as they were urgently required by the municipality who pay for the survey. The fair maps, in 8 sheets, of the new Jeypore survey were also prepared in duplicate, the hill shading being drawn on separate sheets with a view to the hills being printed in brown, which, it is hoped, will improve the appearance of the map when published. In addition to the above, 3 standard sheets, 73, 74, and 75, were drawn and a considerable amount of computation for the Jeypore survey was done and a synopsis prepared. The intersected points of degree sheet VIII were all computed, and the secondary triangles revised, as it was found desirable to alter their arrangement. The computations of degree sheets XIV and XV were also set in order, and the numerical results taken out in readiness for the General Reports which, it is hoped, will be completed during next recess season.

124. The programme for the current field season provides for the extension of the triangulation over degree sheet VII, and, if time allows, over degree sheet VI. The topography of degree sheet VIII will be taken up, also sheets 42 and 57 of degree sheet IX, all on the $\frac{1}{2}$ inch scale, and a small portion of sheet 76 on the 1 inch scale. Parts of sheets 58 and 43 will be triangulated and will eventually be surveyed on the 1 inch scale so as not to break the continuity of the maps of the Pálanpur State.

125. Major Beavan has been directed to supervise the revision of the Ajmere-Merwara topographical maps, for which Mr. Gwynne and two experienced sub-surveyors have been ordered to join this party.

126. Some notes on the town of Bhínmál and the surrounding country by Mr. Tate will be found on page xxx of the Appendix and the cost-rates on page 62 Part II.*

SHWEGYIN DISTRICT, BRITISH BURMA.

(No. 2 Party, Revenue Branch.)

127. Owing to the financial exigencies of the Local Government, the cadastral operations, on which this party had been engaged in Burma since the year 1878-79, were summarily stopped at the conclusion of the last survey season; and as there was no further demand for similar operations in other Provinces, the Government of India, in letter No. $\frac{522}{129-8}$S., dated 18th September 1884, from the Secretary, Revenue and Agricultural Department, sanctioned the retention of this party in Burma for employment on topographical operations, until such time as its services might be again required for revenue surveys elsewhere.

Personnel.

Mr. E. J. Jackson, Officiating Deputy Superintendent, 4th grade, in charge.
Mr. F. Grant, Surveyor, 1st grade.
Mr. H. Dowman, ditto, 3rd ditto.
Mr. J. McHatton, Assistant Surveyor, 1st grade.
Mr. G. E. Parker, ditto ditto, 1st ditto.
Mr. P. A. Peters, ditto ditto, 2nd grade.
42 Sub-Surveyors and others.

128. The Cadastral Establishment was therefore disbanded, and the organisation of the party altered to suit the new requirements. With the approval of the Chief Commissioner, the portion of country selected for survey was that north and in continuation of the area which had been completed cadastrally

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* Major Beavan expresses his regret at losing the services of Messrs. Wilson and Cornelius, who have been transferred from the party, and records his opinion of the admirable manner in which they have peformed their duties while with it; he also reports that the remaining assistants all discharged their duties with zeal and fidelity.

during the previous season in the Shwegyin District; it embraces both banks of the Sittang river, between the parallels of North Latitude 17° 36′ and 18° 20′. The party, which remained under the direction of Mr. Jackson, left its recess quarters at Rangoon on 28th November and commenced field work early in December 1884; the operations were continued until the 15th May 1885.

129. The area topographically surveyed is 1,142 square miles on the scale of 2 inches to a mile; it is all within the Shwegyin District, and comprises the three townships of Thayéthamein, Shwegyin, and Kyaukkyi. The low-lying alluvial tract of country in the Sittang Valley, over which the survey was carried, consists chiefly of *kain* grass, dense forest and swamps, intersected with a network of drainage channels, which would not admit of triangulation, and without much expense and delay, the ordinary and more rapid means of mapping the details from fixed positions obtained by intersections from known points could not be adopted. The survey was therefore executed with the chain and is based on traverses checked by connection with Great Trigonometrical Survey stations. The result of these connections shows that great care has been bestowed on the linear measurements of the skeleton frame work.

130. The boundaries of *kwins* have been traversed in all cases where they were demarcated, and where demarcation was wanting, the traverses were run along natural features so as to form blocks varying from one to two and a half square miles in area, which were subsequently adopted as *kwin* boundaries by the Deputy Commissioner; but in some instances a block has been subdivided and formed into two, three, or four *kwins*, and in such cases the internal boundaries have not been traversed, as they were settled after the party returned to recess quarters: they have however been shown on the maps, as they are in all cases along features which had been surveyed with the plane-table, and could therefore be defined Mr. Jackson reports that the boundary work was carried on under great disadvantages, owing to the ignorance and apathy of the village officials, and to the want of proper demarcation maps; that the maps supplied by the Deputy Commissioner were useless and misleading; and, as an instance, quotes those of the Thayéthamein and Kyaukmaw circles in which 30 *kwins* only were shown, whereas there proved to be 123 *kwins* within them.

131. In the area over which the traverse operations were extended this year, 362 *kwin* boundaries have been rigorously traversed, and the measurements and offsets of the same have been recorded in field books, so that in the event of any future cadastral survey being required, the data will be available for plotting on any scale. All the theodolite stations of the traverse survey have been marked with burnt clay cylinders, which were manufactured by the survey establishment at the small cost of one anna each; 10,266 of these marks have been embedded on or near *kwin* boundaries, and on the sub-traverse stations near cultivation. Due measures have been taken for their preservation, in concert with the Local Government. Printed notices, with plots of the traverses showing the positions of the station marks, have been served on the *Kyadàngyis* or village headmen, who are held responsible for their protection, and duplicates of the same have been lodged in the Deputy Commissioner's Court.

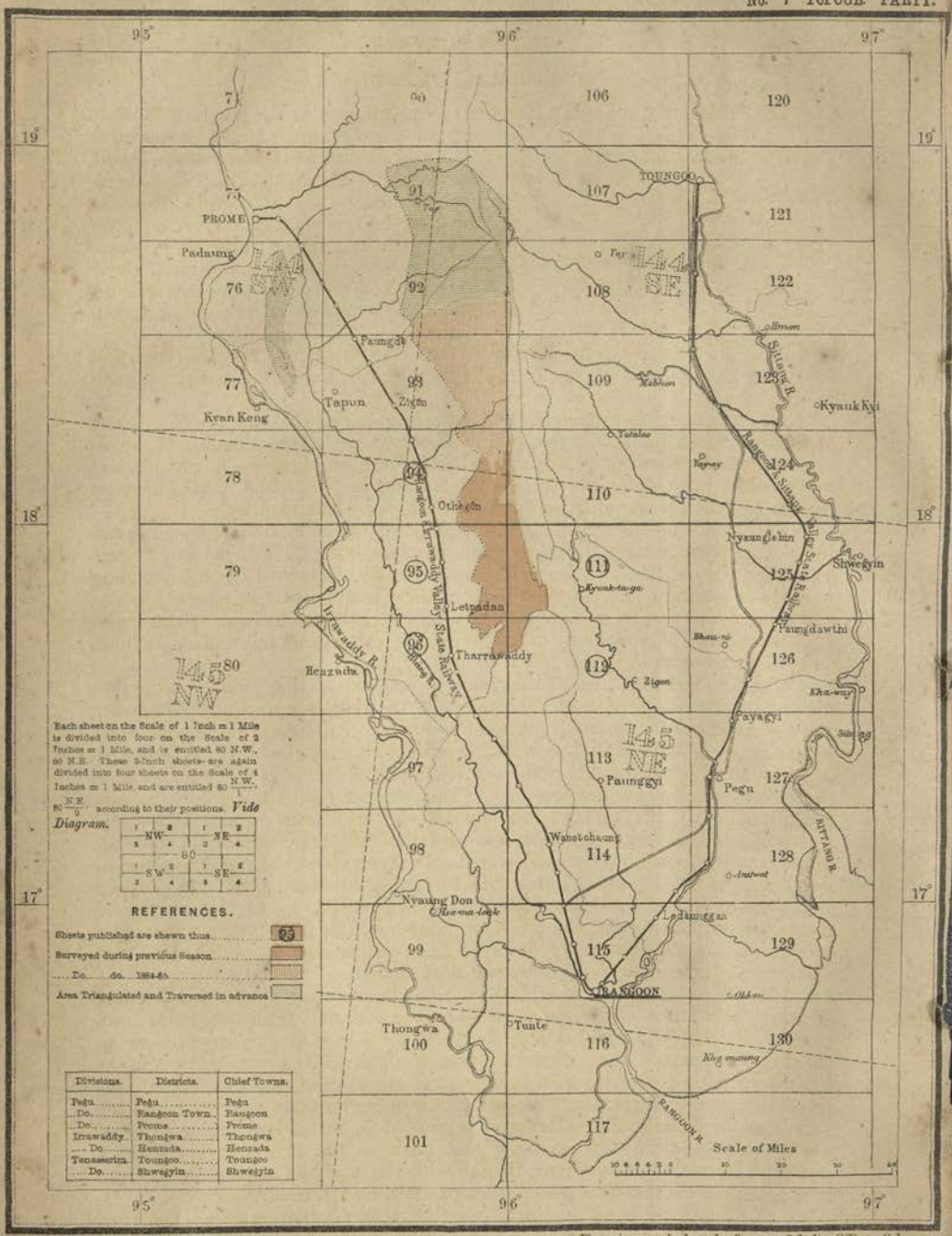
132. Observations for azimuth to check the angular work of the traverses were taken at 57 stations, and check lines aggregating 360 miles in length have been independently measured to test the detail survey; the comparison with the topographical board plans proved the work to have been accurately done.

133. During the field season there were 10 deaths among the establishment, 6 of which were from cholera, and one sub-surveyor, Kowsar Ali, was killed by a tiger whilst asleep in the jungle, where he had encamped in order to be close to his work.

134. The fair maps of all the area surveyed have been prepared on the 2 inch scale and comprise 14 standard-sized sections of Sheets 123, 124, 125, and 126. Traces of the above have been supplied also to the Local Government. All the records connected with the work of this party in Burma have been submitted to head-quarters, and the establishment has now been withdrawn therefrom and transferred to the Central Provinces, where it is commencing,

INDEX TO THE BRITISH BURMA SURVEY.

No. 7 TOPOGL. PARTY.



Each sheet on the Scale of 1 Inch = 1 Mile is divided into four on the Scale of 2 Inches = 1 Mile, and is entitled 80 N.W., 80 N.E. These 2-Inch sheets are again divided into four sheets on the Scale of 4 Inches = 1 Mile, and are entitled 80 $\frac{N.W.}{1}$, 80 $\frac{N.E.}{2}$, according to their positions. *Vide Diagram.*

1 NW 2	1 NE 2
3 4	3 4
80	
1 SW 2	1 SE 2
3 4	3 4

REFERENCES.

Sheets published are shewn thus 95

Surveyed during previous Season .....

Do. do. 1884-85 .....

Area Triangulated and Traversed in advance .....

Divisions.	Districts.	Chief Towns.
Pegu	Pegu	Pegu
Do.	Rangoon Town	Rangoon
Do.	Prome	Prome
Irrawaddy	Thongwa	Thongwa
Do.	Henzada	Henzada
Tenasserim	Toungoo	Toungoo
Do.	Shwegyin	Shwegyin

NOTES.

The names of Cities surveyed on large Scales are underlined thus ..... RANGOON.

The figures and lines in bars represent the numbers and limits of the Engraved Sheets of the Atlas of India ..... 144 S.W.

Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S.C., *Surveyor General of India.*

Survey of India Offices, Calcutta, February 1886

during the current season, a cadastral survey of the Bilaspur District on the system now in force in the North-West Provinces.*

FOREST SURVEYS.

BURMA FORESTS.

135. This party under Mr. Hörst left recess quarters at Rangoon for the field at the end of November 1884; it was divided into four camps: Head-quarters, Detail, Traverse and Triangulation. The Head-quarters camp was at Gyobingauk for the first half, and at Zigon for the latter half, of the field season; both these places being stations on the Burma State Railway have markets where supplies are procurable which proved of the greatest convenience.

Personnel.

Mr. H. Hörst, Deputy Superintendent, 3rd grade.
„ J. H. Wilson, Assistant Surveyor, 1st grade.
„ C. P. Torrens, „ „
„ W. H. Penrose, „ „
„ R. A. Gibson, „ „
„ E. Graham, „ „

Sub-Surveyors.

Venkat Swamy.	Sumer Sing.
Sher Shah.	Rahmat Ali.
Durgaia.	Abdulla Khan, and 20 others.
Husain Bux.	

136. The Traverse camp worked in the Shwele tract, Prome, district, and in Upper Zamayi east of the Pegu Yoma range in the Toungoo district, completing an area of 500 square miles.

137. Triangulation was carried on in the Shwedaung Hill tract, in Shwele and Myodaung of the Prome district, and in Toungoo east of the Yoma hills, covering altogether an area of 814 square miles. Triangulation was much impeded by the dense haze which overspreads the country in March and April, in consequence of which it can only be carried on for about four months.

138. The whole of the country topographically surveyed this season belongs to the Tharrawaddy district, except small portions lying in Toungoo and Prome. The out-turn on the 4″ scale is 314 square miles of reserved forests, including 8 miles of overlap; that on the 2″ scale is 44 square miles of unreserved forests and ground likely to be brought under cultivation, and includes 8 square miles of overlap also. The accuracy of the work was tested by 91 miles of check lines, and, with one exception, was found to be very good.

139. The main features of the country plane-tabled this year are more prominent than those previously surveyed, but the details were quite as minute, and the nature of the ground rendered the work more arduous. The Yoma range, which runs right through the work, is still a very marked feature, although it dwindles down in some parts to a few hundred feet and is traced through the forest by means of the drainage. The western fall of the range is very precipitous, and cut up by innumerable water-courses. Proceeding more westward, the elevation becomes less and the hills more accessible, but the lower ground is much broken and covered with dense forest and still denser underwood, in which it is almost impossible to follow the watersheds. The eastern slopes are easier and the features bolder, which would expedite the work were it not for the dense evergreen forest and impenetrable cane brakes which offer serious obstacles to progress: however more experience is gained daily and obstacles are now more easily overcome than at first.

140. The total area surveyed in detail up to date amounts to 714 square miles, of which 618 are on the 4″ scale and 96 on the 2″ scale. The survey was commenced in 1882-83, and will occupy the party for a good many years to come, as the Forest Reserves alone cover an area of about 4,000 square miles, and the difficulties to be contended with in every way are so great that the annual outturn is comparatively small. The party now being properly organised, and the surveyors, &c., acclimatized, the work executed in the season under report is not only considerably in excess of the areas of the two previous seasons, but superior to that of last year, though with the party at its present strength it is not expected that this season's outturn will be exceeded.

141. The strength of the party was not fully effective as regards sub-surveyors; 4 who were entertained last year, needed further instruction, and 2 who were appointed at the commencement of the field season did no work, as their health broke down and they had to be sent back to India. One assistant

* Mr. Jackson reports favourably of the services of Messrs. Grant and Dowman, who had charge of the two separate camps, and adds that Messrs. McHatton, Parker and Peters performed their duties to his entire satisfaction.

surveyor suffered from fever intermittently for half the season, and among the sub-surveyors generally there was a good deal of sickness. The health of the menial establishment was fairly good; out of 560 khalassies, there were 397 admissions to hospital, but only 3 deaths occurred through sickness, and 1 mahout was killed by his elephant bolting. The weather was unusually cool at the commencement of the season, but exceptionally hot from the beginning of March.

142. The transport consisted of 12 elephants, of which 3 were unserviceable from sore backs, &c., and 1 died during the field season; 2 were obtained on loan from the Commissariat Department, but as several were required for the carriage of baggage, those available for transport of provisions were greatly overworked. Three provision depôts were maintained during the early part of the season, and 5 afterwards; one was 40 miles, two were 30 miles, one 23, and another 16 miles from the base of supply on the line of railway. On these depôts 600 men depended for every necessary of life, as no supplies of any sort can be obtained from the Karens on the spot, which is one of the many difficulties met with in surveying this country.

143. The want of water is another of the serious difficulties the surveyor has to contend against. It becomes so scarce in April and May, that it is often doubtful whether it will be possible to complete some tracts, the omission of which would be undesirable. When digging fails to produce it, which is often the case, the supply is brought from long distances, entailing much loss of time.

144. At the request of the Chief Commissioner, earthen pipes, to serve as a groundwork for a large scale survey which may hereafter be required, have been laid down along traverses run in certain tracts which are to be surveyed on the 2″ scale, as likely to be brought under cultivation. The cost of laying down these pipes is to be considered an extraordinary charge.

145. Recess work commenced again at Rangoon on the 28th May 1885, during which 17 standard sheets, more or less complete, have been in hand, of which none are in arrears. Exaggerated 2″ sheets were taken up but not completed. An office chart of traverse points was drawn in duplicate, besides 2 reductions to half scale; also 13 sheets on the 4″ scale and 3 on the 2″ scale of plots completed for the field sections of the ensuing season. In the early part of the recess season, and in November, work was carried on during extra hours to prevent the mapping falling into arrears.

146. Next season it is intended to extend the detail survey to the north of that already completed as far as Lat. 18° 45′, and westwards to the limits of the Cadastral Survey, confining operations to the Tharrawaddy, Prome and Toungoo districts. The Taungnyo and Shwele reserves, with their sub-divisions and interlying or adjoining Karen areas, will be included, also an undemarcated forest tract between Long. 96° and the Pegu Yoma range, as well as the Juma Tyaukmaw Reserves, with an unreserved forest tract in Shwedaung stretching from 5 miles west of Tapun to Prome town. About 270 square miles will be surveyed on the 4″ scale, and 230 square miles, comprising unreserved forest tracts, on the 2″ scale.

147. The Traverse Survey will extend north of Lat. 18° 45′ and west of Long. 96°, and will include the western and part of the eastern slopes of the Yoma range, and the unreserved forest tracts in Myodaung, an area of about 450 square miles, over which the triangulation was extended during this field-season.

148. The triangulation will be carried over about 400 square miles, west of Long. 96° and up to the northern boundary of the Prome district, of which area all but 90 square miles will be absorbed by the Traverse Survey.

149. At the desire of the Chief Commissioner of British Burma, after the unreserved forest tracts in the Shwele and Myodaung townships have been surveyed, the operations of the party will be confined almost entirely to the reserved forests, or those likely to be brought under reservation.

150. Extracts from Mr. Hörst's narrative report will be found at page xxxii of the Appendix and the cost rates at page 62 Part II.*

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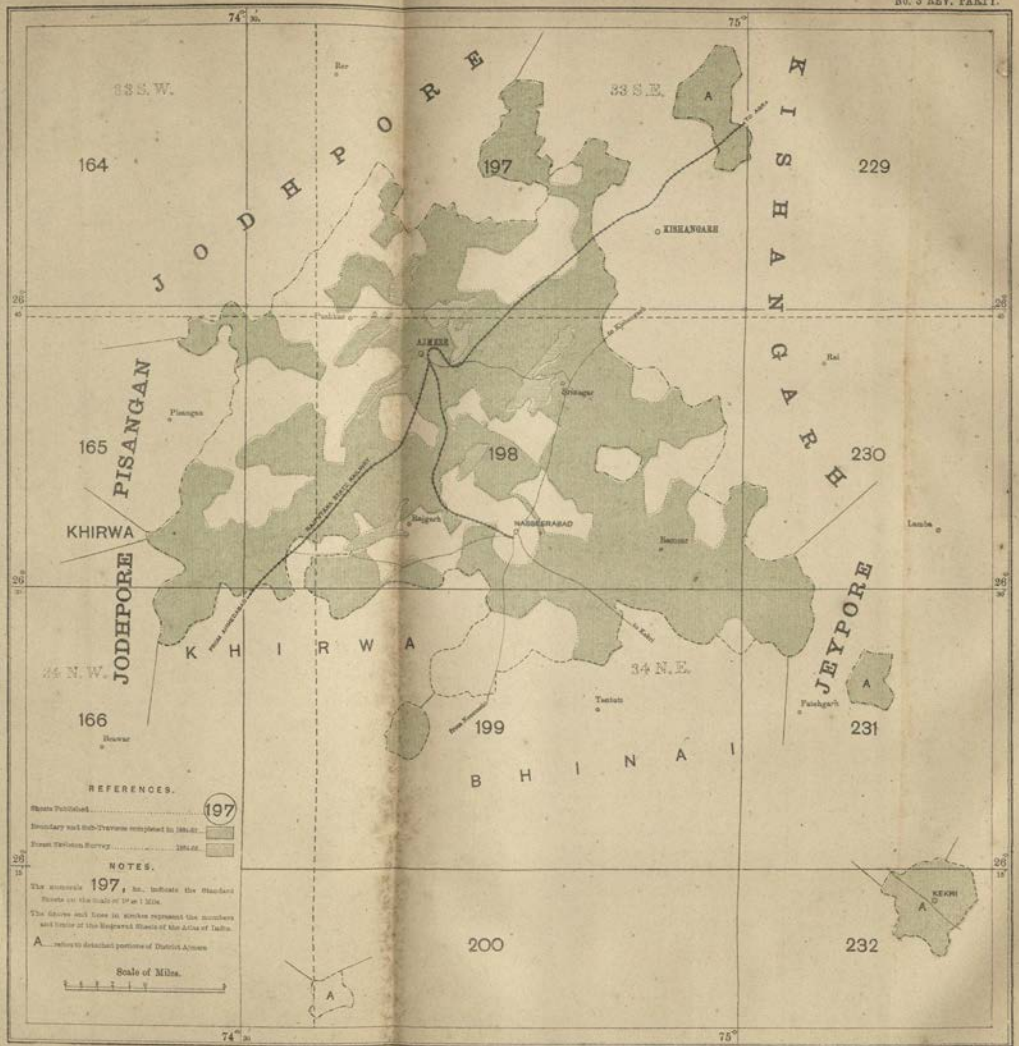
* Mr. Hörst reports that Mr. Wilson conducted his arduous duties in a very satisfactory manner. Mr. Torrens exercised considerable judgment in selecting his traverse lines and in disposing the sub-surveyors under his orders. Mr. Gibson surveyed, in excellent style, a difficult tract with energy and rapidity, while in office he contributed largely in bringing up the season's mapping. Sub-surveyors Venkat Swamy, Sher Shah, Durgaia, Hussain Bux, Sumer Sing, Shurfuddin and Ahmad Sayad, are commended for their steadiness, perseverance, and devotion to their duties.

AJMERE-MERWARA

INDEX TO THE SURVEY OPERATIONS IN DISTRICT AJMERE.

No. 3 REV. PARTY.



REFERENCES.

Sheets Published 197

Boundary and Sub-Trevers completed in 1884-85 .....

Forest Revision Survey 1884-85

NOTES.

The numerals 197, &c., indicate the Standard Sheets on the Scale of 1" or 1 Mile.

The figures and lines in circles represent the numbers and limits of the Engraved Sheets of the Atlas of India.

A ..... refers to detached portions of District Ajmere.

Scale of Miles.

Published under the direction of Colonel G. C. De Prée, S.C., Surveyor General of India.

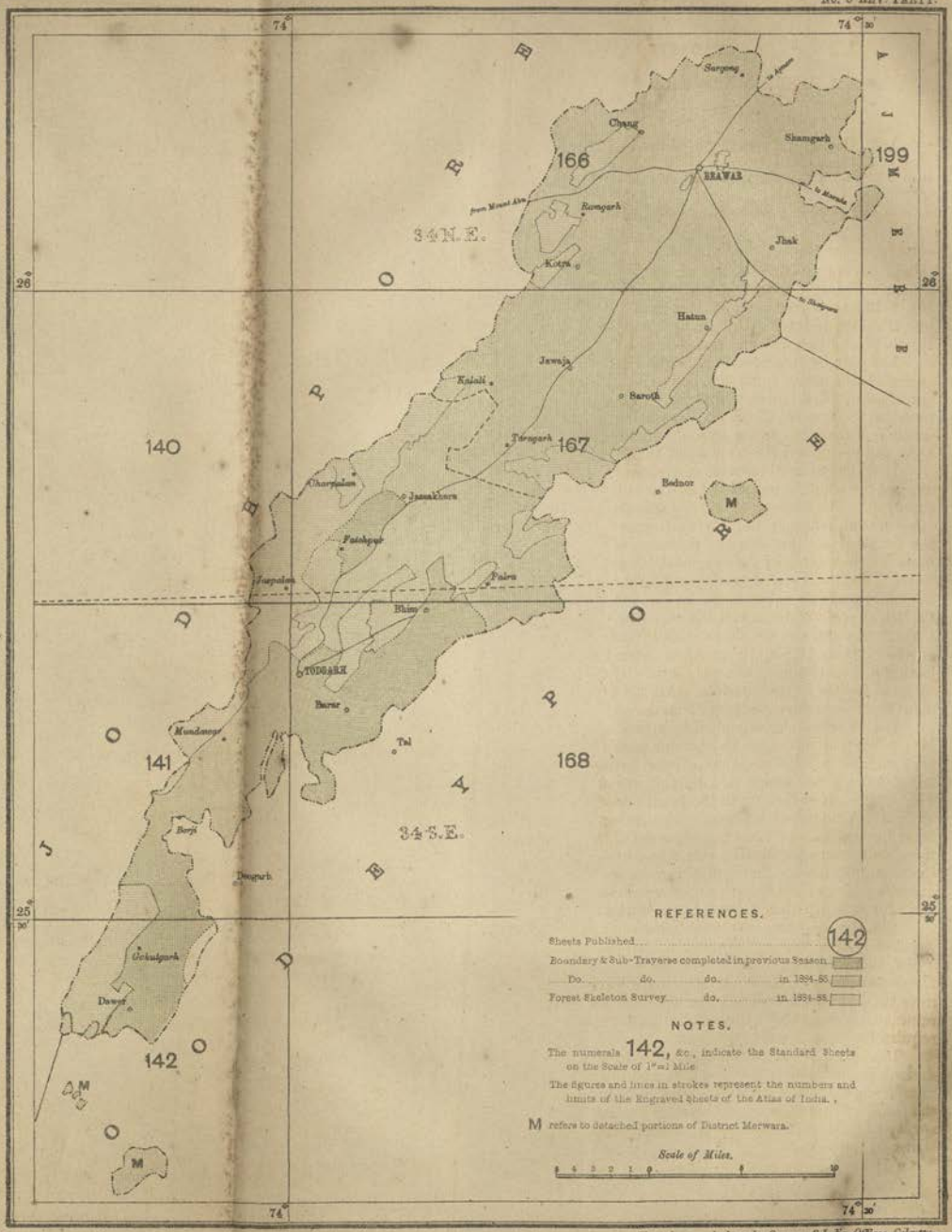
Survey of India Offices, Calcutta, February 1886.

Photozincographed at the Survey of India Offices, Calcutta.

AJMERE-MERWARA

INDEX TO THE SURVEY OPERATIONS IN DISTRICT MERWARA.

No. 3 REV. PARTY.



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Survey of India Offices, Calcutta, February 1886.

CADASTRAL SURVEYS.

AJMERE-MERWARA DISTRICT, RAJPUTANA.

(No. 3 Party, Revenue Branch.)

151. During the year 1883-84 a small detachment, under the charge of Mr. A. J. Gibson, Surveyor, 3rd grade, had commenced the traverse and boundary survey of Merwara to the south and had completed an area of about 100 square miles; but as it was required to complete the skeleton survey of the whole of the *khalsa* villages (lands paying revenue to Government), which comprise an area of about 1,200 square miles, it became necessary to depute a full party for the undertaking. No. 3 Revenue Party, which had been previously employed on 2 inch topographical survey in the Doab districts of Aligarh and Etah was withdrawn from the North-West Provinces and transferred to Ajmere for this purpose.

Personnel.
Major E. H. Steel, Offg. Dy. Supdt., 4th grade, in charge.
Mr. A. J. Gibson, Surveyor, 3rd grade.
„ C. W. F. Seyers, Assistant Surveyor, 1st grade.
„ F. W. Moore, ditto, 3rd „
„ T. W. Babonau, Jr., ditto, 3rd „
30 Sub-Surveyors and others.

152. Major Steel remained in charge of the party, the constitution of which, as regards the native surveyors, had to be considerably changed owing to the different class of work it was to undertake. This necessitated the training of a large number of men in theodolite traversing, which was arranged for, as far as possible, during the recess season. Field work was commenced on 15th October 1884 and continued till 16th April 1885.

153. The operations were carried on in districts of Merwara and Ajmere and covered the whole extent of the *khalsa* villages, the portion which required to be surveyed. The system of survey was the same as that adopted during the previous season, whereby the Survey Department furnishes skeleton maps showing the boundaries of villages and positions of permanent marks within them, as a basis for the survey of the interior fields and other features to be executed by patwaris. The out-turn of work completed covers an area of 1,000 square miles of boundary and interior traverse on the 16 inch scale, and of 145 square miles on the 4 inch scale of the forest tracts. The boundary traversing aggregates 1,385 linear miles and the simple interior traversing 1,844 linear miles. All stations of observation, 13,803 in number, have been marked by stones, $18'' \times 6'' \times 4''$ having a special mark cut on the top. The 4 inch scale survey includes all the reserved forests in the districts. All the details required by the Forest Department have been surveyed, *viz.*, boundaries, roads, and fire-lines.

154. The country operated in proved to be very difficult for traverse work. Major Steel reports that the greater part of Merwara is mountainous and of a very rugged nature, and that at least half of the portion of Ajmere that came under survey was rough and difficult ground for carrying chain measurements. The work was subjected to the usual tests; the main traverses were connected with trigonometrical stations. The nature of the ground necessitated a somewhat higher limit of error being passed than is usually allowed in such operations, but every precaution was taken to obtain the best results possible under the circumstances. The comparison between the triangulated and the chained distances in eight cases gives an average error of 9·3 feet per mile. Observations for azimuth were taken at 102 stations to check the angular work.

155. The traverse survey includes 453 villages and has been mapped on upwards of 1,500 sheets on the scale of 16 inches to a mile. With the exception of a few, these were handed over to the Settlement Officer by the 9th of October. Duplicate copies of these skeleton maps have been prepared for reproduction, in order that fresh maps may be available for the patwaris when required for remeasuring the fields; the cultivation being of a shifting nature and likely to require frequent re-survey.

156. In addition to the actual survey work, the Deputy Superintendent undertook the permanent demarcation, and the instruction of the whole district staff, numbering 232 patwaris and others, in cadastral surveying; and it is hoped that the result of this training will enable the Settlement Officer to get a fairly good survey of the cultivated area from their hands. On this subject Major Steel writes as follows:—

"All the patwaris have passed through a course of training in surveying in the field,

according to the principles adopted in the Survey Department. They showed, without exception, great interest in the work, learned it eagerly and displayed ability which was far beyond that shown by the few men of the same profession whom I inspected in the Central Provinces some two years ago. There is no doubt that excellent survey work can be performed by this class of men if they are properly superintended, but it is unreasonable to suppose that the mere fact of teaching a body of men the rudiments of field-surveying will do more than 'set them on the track.' If they are to continue to work well and to improve, they must be superintended by officers who have had special training in this work. These patwaris may be expected for a short time, at all events, to adhere to the tenets of the Survey Department which have been instilled into them, but it is improbable that they will continue to survey very long without considerable deviation from the standard which has been set up; for beyond the inspection of the Settlement Officer himself, there is no further European superintendence. Again, the record of rights, &c., is uncared for beyond the modicum of attention which the Settlement Officer can afford to spare for it from his multifarious duties."

157. A plot of the boundary traverses has been projected on the 2 inch scale, and the boundaries are being inserted by reduction from the original survey. This will afford the Settlement Officer an excellent index to his work, and on it a new map of the country could be made from the topographical details which will be furnished by the patwaris, provided they are checked by any reliable agency.

158. The operations in the *khalsa* villages completed the work which had been allotted to the party; but the question of the extension of traverse survey to *jagir* villages (revenue-free grants), an area of 227 square miles, was raised in November 1884 and recommended by the Chief Commissioner. Major Steel then reported that as the *khalsa* and *jagir* villages are so intimately intermixed, the additional cost and labour of including the *jagir* villages in the survey would be small, if it were done *pari passu* with that of the *khalsa* villages, and that it could be undertaken without difficulty if orders were received in sufficient time. Unfortunately no decision was arrived at until after the party had returned to recess quarters, and it was not until June 1885 that orders were received from the Government of India sanctioning the undertaking. A small detachment therefore has been sent to Ajmere under the charge of Mr. Gibson to carry out the traverse survey of these *jagir* villages during the current season.*

AKYAB DISTRICT, BRITISH BURMA.

(No. 7 Party, Revenue Branch.)

Personnel.

Mr. H. B. Talbot, Officiating Deputy Superintendent, 3rd grade.
" F. W. Kelly, Assistant Superintendent, 1st grade, up to 30th June 1885.
Mr. C. W. Jarbo, Assistant Surveyor, 1st grade.
" J. R. Scott, " " "
" J. S. Swiney, " " "
" A. W. Smart, " " "
" G. S. Willes, " " 3rd grade.
21 Sub-Surveyors and others.

Temporary Establishment.

105 Field Surveyors and others.

Field operations were resumed by this party on 15th November 1884 and were continued until the end of May 1885. Cadastral work has been carried on in the five townships of Akyab, Urittaung east and west, Rathedaung and Naaf, which were sub-divided into 42 circles, of which 16 have been completely and 26 partially surveyed.

159. The out-turn completed consists of 562 square miles of cadastral survey on the 16 inch scale, 70 square miles of river survey on the 2 inch scale, and 2·50 square miles of the Akyab town survey on the 64 inch scale. Of the cadastral area, 241 square miles are cultivated and the remainder consists of jungle land, hills and water. The cultivated area includes 11,91,392 fields, having an average size of 0·13 of an acre, which is much smaller than those previously met with. In addition to the above areas, preliminary boundary traversing has been carried over 236 square miles for the work of next season.

* Major Steel reports of his assistants as follows:—

"Mr. Gibson has rendered every assistance, he is thorough in all he does, and his combined knowledge of topographical and revenue work renders him a peculiarly valuable assistant.

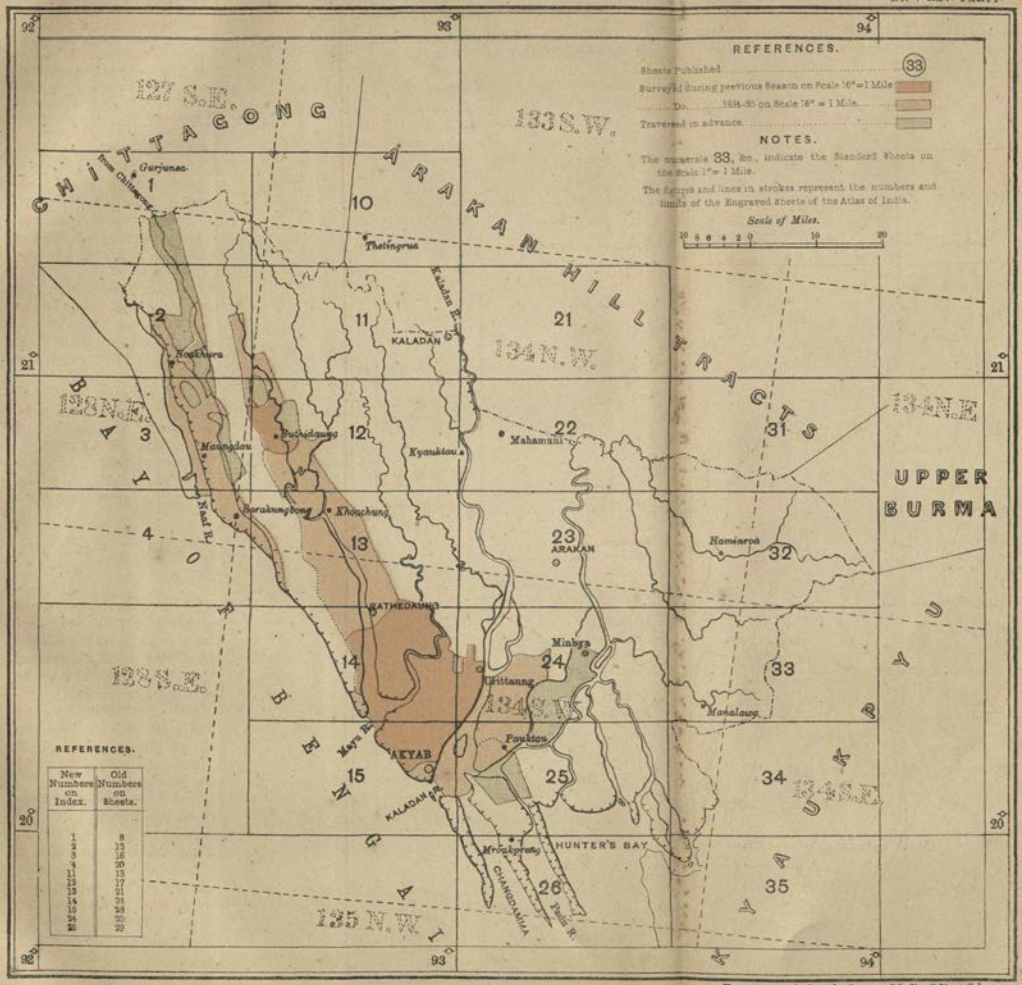
"Messrs. Moore and Babonau are alike worthy of much commendation and give every promise of attaining great proficiency in their profession; of Mr. Seyers, I regret I cannot report favourably."

Of the native establishments, the following are specially mentioned:—Baboo Bhagobutty Charan Chuckerbutty, Pundit Kedar Nath, Mahomed Bux, Mahomed Zakeria, Abdul Karim, and Piari Lal. Jogendra Chunder Ghosal and Surfraz Khan are commended.

BRITISH BURMA SURVEY

INDEX TO THE CADASTRAL SURVEY OF DISTRICT AKYAB.

No. 7 REV. PARTY.



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Survey of India Offices, Calcutta, February

1886

160. The Mayu range of hills which runs through the cadastral area and divides the work in two, has not been surveyed, as it was not required for settlement purposes. Mr. Talbot's orders from the Local Government were to exclude such tracts from survey, except the portions which fall within *kwin* and grant boundaries. The omission of these hill tracts from the survey will leave considerable gaps in nearly all the standard topographical sheets, and it is hoped that arrangements may be made for a topographical detachment to be posted to this party for the purpose of filling in such areas on the 2 inch scale so that the geographical maps may be rendered complete. The peculiar configuration of the tracts of country marked out for cadastral survey, combined with the long distances over which the work was scattered, rendered supervision difficult, but the work has been nevertheless very carefully checked by lines of re-survey run through every section; the European assistants having executed 410 linear miles and the native inspectors 586 linear miles. The detail survey is reported to have been found honestly done by the field surveyors. Connections have been made from the traverse work with six stations of the great trigonometrical survey, and the chain measurements have been corrected to agree with the trigonometrical distances. The average error of the chaining was found to be 2·19 feet per mile. Observations for azimuth have been taken at 67 traverse stations to check the angular measurements.

161. The permanent demarcation of the traverse stations, to provide for the accurate mapping hereafter by the local supplementary survey establishment of new cultivation, has been effected. Stations at about half a mile apart have been marked with stone prisms, both around boundaries and in the interior blocks or sub-divisions of *kwins*.

162. The revision of the previous season's work in Prome and Akyab was also carried out, but under different rules drawn up by the Local Government, which has considerably reduced the labour of these operations. Only those maps in which large extensions of cultivation have taken place, or in which the errors are so grave that it would not be possible to make use of them for settlement purposes, are now returned to the Survey Department for correction. This has simplified the revision work very considerably. The sheets of the previous season, 517 in number, have been revised and completed and despatched to Calcutta for publication.

163. In the large scale survey of the town and civil station of Akyab, 64 inches to the mile, which covers an area of about 16,000 acres, no field books have been kept, but all the measurements have been recorded on the sheets in blue. This survey is mapped on 41 sheets, and should they be required to be reproduced at some future date, the measurements, being in blue, will not appear.

164. A portion of the programme could not be completed, and an area of about 80 or 100 square miles, chiefly hills falling within the cadastral area, had to be left for the next season owing to the paucity of hill surveyors. This, however, will not interfere with the requirements of the settlement officer on account of revisions, as the hills are not required to be shown on traces furnished to him and it can be readily undertaken by the detachment that has to complete the revisions during the current year.

165. The cadastral area has been mapped on 905 sheets, which, however, have been retained in the field office to complete the revisions thereon during the current season. The traces of about 200 *kwins* with their area statements had been made over to the Settlement Officer, and it was expected that the balance would be delivered to him before the party took the field again.

166. The training of indigenous surveyors has been continued; hopes had been entertained that the Arakanese boys who had been trained during the previous year would have returned for employment, but they failed to do so, and it is a well-established fact that, after the pupils have learnt their work and have received survey certificates, they look out for more lucrative appointments in other departments. During the year under report, only 27 boys were under training, of which number 8 passed satisfactory examinations and received survey certificates. Regarding his experience of the Arakanese on this subject, Mr. Talbot reports as follows:—

"During the two years that this party has been at work in the Akyab district, there have been no Arakanese actually employed on the work, but 26 boys were under training the first

year and 27 in the second year; of these, 14 passed very fair examinations and received survey certificates.

"The Arakanese will not, as a general rule, take service as surveyors, but they do not object to serve as computers, whose duties are sedentary. The 14 boys who qualified in surveying did not care to stay on; they demanded certificates and left. In my opinion there is no inducement in the Survey Department for them to stay, as other departments pay much higher salaries than we can ever do."

167. The area remaining for cadastral survey in this district is about 1,100 square miles, which will take the party two field seasons to complete. Of this, 1,000 square miles is situated on the left bank of the Kaladan river and 100 square miles on the Maungdaw side which was left incomplete this season.

168. Mr. Talbot retired from the Department on 26th October 1884 after a service of over 36 years; of this about 18 years were passed in the Junior Division during which time he was engaged in both Trigonometrical and Revenue surveys. Mr. Talbot has been connected with the Cadastral surveys since the year 1872, and for the last seven years he has supervised cadastral operations in Cuttack and British Burma, in which he has done excellent service.*

BASSEIN AND HENZADA DISTRICTS, BRITISH BURMA.

(No. 8 PARTY, REVENUE BRANCH.)

169. Owing to the decision of the Local Government to reduce the number of cadastral parties in Burma from financial exigencies, this party was one that was selected for withdrawal at the end of the year under report. The operations were therefore confined to the completion of the cadastral area remaining for survey in the Bassein and Henzada districts.

170. The preparatory boundary traversing of this area had been executed during the previous season, and it only remained to fill in the detail survey and to revise the maps of the previous year. The boundary establishment therefore was withdrawn and transferred to other parties, and field operations were commenced, with a reduced establishment as given in the margin, on 15th December 1884, and were continued till 15th May 1885, when the party returned to Rangoon for the recess season.

Personnel.

Major H. S. Hutchinson, Deputy Superintendent, 4th grade, in charge.
Mr. H. R. Littlewood, Surveyor, 2nd grade.
" R. B. Smart, ditto, 4th do.
" T. H. Dunne, ditto, 4th do.
" W. H. D. Ewing, Assistant ditto, 2nd do.
16 Sub-surveyors and others.

Temporary Establishment.

91 Field Surveyors.

171. A total area of 900·47 square miles came under survey during the season, and this completed the work allotted to the party. The separate areas accomplished on the several scales are given in the following statement:—

District.	Number of kwins.	Cadastral. Square miles.	Topographical. Square miles.		
		16 inch scale.	16 inch scale.	4 inch scale.	2 inch scale.
Bassein	63	78·15	5·36	11·31	79·30
Henzada	192	549·01	...	11·60	165·74
TOTAL .	255	627·16	5·36	22·91	245·04

172. The positions of portion of the work were much scattered and involved long journeys, which caused delay. The topographical work comprised large

* Mr. Talbot reports as follows regarding the services of his Assistants:—

"Mr F. W. Kelly, Assistant Superintendent, has kept up his reputation in every way; he is an excellent Assistant and would do credit to any party.

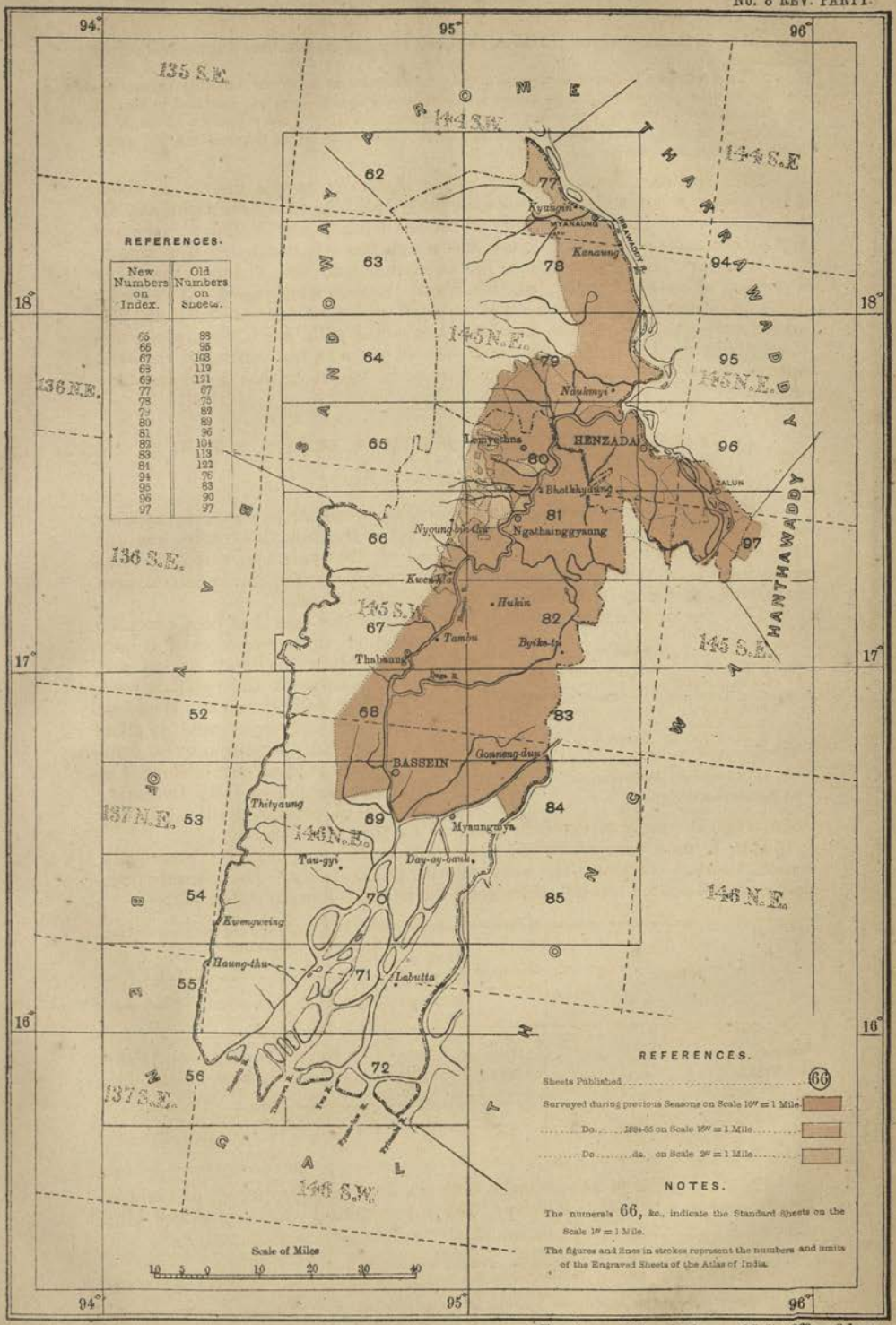
"Messrs. Jarbo and Scott are both deserving of praise; they are intelligent, hard-working, and competent officers, who carry out orders promptly with good tact and management."

Messrs. Swiney and Smart are also favourably reported on, and the following members of the native establishment are specially mentioned:—Nand Lal Chatterji, Shoshi Bhusan Ghosal, Kedar Nath, Dindyal, Amachellam, Faiz Buksh, and Balkishen.

BRITISH BURMA SURVEY

INDEX TO THE CADASTRAL SURVEY OF DISTRICTS BASSEIN & HENZADA.

No. 8 REV. PARTY.



Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S.C., *Surveyor General of India.*

Survey of India Offices, Calcutta, February

1886.

tracts of forest and hills and rivers which were surveyed on the various scales according to their position and importance. Some parts were found to be very inaccessible, and the work involved heavy line-cutting.

173. In the cadastral area 501,019 fields have been surveyed, having an average size of 0·33 of an acre. The usual checks have been adopted for testing the accuracy of the work; every field plan has been examined, and no final check line was allowed to be measured until the field section had been lodged in the camp office.

174. The work of the season under review touches on its northern limit upon that of the survey of the Prome and Tharrawaddy districts, executed by No. 7 revenue party. The result of a comparison between the two surveys of the common boundary along the Irrawaddy river is found to be good.

175. The revision survey in the area mapped during the previous season has been carried out. It had been expected that this correction of the former year's survey would become less laborious and expensive as the survey and settlement officers gained more experience of the country, but the result has proved quite the contrary. In order to relieve the increasing labour and expenditure under this head, the Chief Commissioner ordered certain alterations in the procedure, which limited the return to the Survey Department of such maps only in which the omissions could not be easily corrected by the local Supplementary Survey Department in the following year; and further directed, as a tentative measure, that an endeavour should be made to carry on the revision work in the same season in which the original survey is done. This experiment has been made in Henzada during this season, and Major Hutchinson reports as follows on the result:—

"(1) By this arrangement the survey of all extension of cultivation after the original survey has been made has been avoided, and this change has at once reduced by two-thirds the labour of what has hitherto been misnamed revision work.

"(2) It has been found feasible, without unduly taxing the Survey Department, to keep up the revision work to within one month of the original survey work.

"(3) Out of a season's area of 627 square miles, all but about 100 square miles have been finally passed by the Settlement Department, at the trifling expenditure of about ₹1,240 for salaries of holding recorders attached to the Survey Department."

176. The above results appear to be very satisfactory and tend to prove that it is most desirable for the survey and settlement operations to proceed together, whereby a great reduction of labour and saving to Government will be effected.

177. Regarding the training of Burmans in surveying during the season, Major Hutchinson reports as follows:—

"Every possible effort was made to afford opportunities of instruction to the Burman pupils; besides those attached to the amins, Moung Eli, teacher of the Henzada Survey School, took the field with us with 27 class boys, and providing his own instruments and labour, he succeeded in passing several of them through the prescribed course, as well as to do a portion of work himself, by way of practice. On the whole, 89 qualified themselves in the principles of filling in cadastral survey details; the work done by these pupils was good in quality, equal to first class work, but their rate of progress was slow; only a very limited piece of work could be given to each pupil to enable all to have a chance. The Government has made the possession of a survey certificate a *sine qua non* to obtain civil employment, and we have had more applicants for training than it has been possible for us to pay proper attention to. As long as the present supply of civil appointments continues, the Burman will use the Survey Department simply as a stepping-stone to more congenial and lucrative employment, and I have not come across a single instance of a Burman who desires to make field surveying a permanent means of gaining a livelihood."

178. Owing to the necessity of bringing the party to India in October, in order that the operations on the new field of survey allotted for the ensuing season might be commenced in proper time, the recess period was much restricted. A stronger establishment was kept up to enable the mapping of the season's work, which usually occupies six months, to be completed in four months. The area cadastrally surveyed has been mapped in 734 sheets, and the general maps on the 2 inch scale have been prepared in 28 quarter sheets of the standard size. The whole of the work connected with the Bassein and Henzada districts was thus successfully brought to completion within the time and cost estimated for it. All the maps and records connected therewith have been deposited in the Calcutta Office, and Major Hutchinson and his assistants deserve credit for the

efficient manner in which the large amount of work done during the year has been completed.

179. This party has now been transferred to Behar and is inaugurating the experimental cadastral survey of the Mozufferpore district under the command of Lieutenant-Colonel Barron, who has lately returned from furlough and was selected for this important undertaking on account of his long experience in cadastral surveys and his connection with the development of the new system of the joint inter-working of the Survey and Settlement Departments in carrying out the preparation of the record-of-rights. Major Hutchinson, on account of his experience in Burma, has been selected to take charge of the Akyab party, which has lost its Superintendent by the late retirement of Mr. H. B. Talbot, on superannuation pension.*

BASTI DISTRICT, NORTH-WEST PROVINCES.

(No. 4 PARTY, REVENUE BRANCH.)

180. This party, which remained under the charge of Major Cowan, left its recess quarters, Naini Tal, on 17th October and resumed field work in the Basti district on 27th idem. The traverse operations were continued until 14th April 1885, but the detail survey work was not closed until the end of May, when the establishment returned to recess quarters where office was reopened on 2nd June 1885.

Personnel.

Major S. H. Cowan, Deputy Superintendent, 4th grade, in charge.
Mr. G. H. Cooke, Officiating Deputy Superintendent, 4th grade, from 12th May to 26th July 1885.
Lieutenant H. M. Jackson, R.E., Assistant Superintendent, 1st grade, from 15th to 30th September 1885.
Mr. J. S. Pemberton, Surveyor, 2nd grade, from 11th November 1884.
Mr. H. J. Hanby, Surveyor, 3rd grade.
„ W. J. O'Sullivan, „ „ from 26th August 1885.
„ W. C. Price, „ 4th grade.
„ E. P. S. Hill, Assistant Surveyor, 1st grade, up to 23rd May 1885.
Mr. L. F. Berkeley, Assistant Surveyor, 2nd grade.
„ B. R. Hughes, „ „ 3rd „
„ W. E. Johnson, „ „ „
22 Sub-Surveyors and others.

Temporary Establishment.

363 Field Surveyors and others.

181. The cadastral operations and preparation of the Record-of-rights of the season have been carried on in parganas Amorha, Nagar east and west, and Basti east and west. The party has also been engaged on the survey, on the 4 inch scale, of a line of river side villages in the Fyzabad district, on the right bank of the Gogra river, which has been extended as far as the cadastral survey on the Basti side has been completed. This survey has been undertaken under the orders conveyed by the Government of India, Revenue and Agricultural Department, in letter No. 103, dated 3rd September 1881, to the Surveyor General.

182. The separate areas in the different districts and on the different scales are shown in the following statement :—

DISTRICT.	Description and scale of survey.	Number of villages.	Number of fields.	Area in square miles.
Basti	Cadastral 16 inch.	2,172	11,02,226	666·58
Fyzabad	Mouzawar 4 inch.	44	...	69·81
	TOTAL .	2,216	11,02,226	736·39

183. In the cadastral area the civil station and the villages of old and new Basti are included, which have been surveyed on the 32 inch and 80 inch scales

* Major Hutchinson reports as follows on his assistants :—"Mr. Littlewood has fully sustained the excellent character given to him in former reports; not only is he efficient in every branch of the work connected with cadastral survey, but is possessed of tact. Mr. R. B. Smart has this season had charge of a cadastral camp, and has proved himself able and efficient in the duties thereof. He is a most valuable assistant. Mr. Dunne is a steady, methodical and reliable assistant. Mr. Ewing served under Mr. Littlewood, who reports very favourably of him."

NORTH WEST PROVINCES SURVEY

INDEX TO THE CADASTRAL SURVEY OF DISTRICT BASTI.

No. 4 REV. PARTY.

Published under the direction of Colonel G. C. De Prée, S.C., Surveyor General of India.
Survey of India Offices, Calcutta, February 1886.

Photozincographed at the Survey of India Offices, Calcutta.

on the requisition of the Settlement Officer, who furnished the funds for the same. In addition to the above operations, preparatory traverse has been extended over 729 square miles in advance for the cadastral survey of next season.

184. The system of survey has been continued as in previous years, but the system of writing the village records underwent several changes. From the results experienced in 1883-84 when the survey of this district was commenced, it was found necessary to represent to the Board of Revenue, North-West Provinces, that, in consequence of the Settlement Officer objecting so strongly to the system, known as the Benares system, which has been described in previous reports, little advantage could be expected from continuing the joint interworking of the Survey and Settlement Departments under the existing conditions. The Board directed certain alterations in the Benares system, and under these arrangements the work in 1884-85 was commenced. In November 1884, however, another Settlement Officer was appointed, who promptly decided to develope the Benares system, on the lines of the Gorakhpur system, and to make over to the Survey Department the entire preparation of the rough record, including the Hindi portion, and of all such assessment statistics as could be compiled with sufficient accuracy previous to the attestation, retaining, however, a staff of settlement *munsarims* to check the soil demarcations and the records of certain villages as they were being written, and to submit special reports on the accuracy of the *khanapuri*. This new procedure was introduced during December 1884, but it was not in full working order till January 1885. Extracts from Major Cowan's narrative report giving details of these operations will be found at page xxxiii of the appendix.

185. This expansion of the work of the survey party necessitated raising an extra establishment during the field season. A statistical office was established in each of the cadastral camps in January when the preparation of the statistics, &c., was commenced, and it is to the credit of Messrs. Hanby and Price, the officers in charge, that they succeeded in carrying out this extra duty without any interruption to the other current work.

186. The average size of the fields in the villages of which the records have been made over to the settlement officer is 0·384 acre; and the average number of fields on one *jamabandi* slip, *i.e.*, the number of fields held on one separate tenure, is only 3·387, an unmistakeable evidence of the complicated nature of the tenures in the Basti district.

187. It had been estimated that the party would have completed an area of 800 square miles; but when this estimate and its cost was framed it was anticipated that writing the records would enable the survey to lump up several contiguous fields held by one cultivator into one survey number, and thus keep the average size of the field up to 0·75 acre. This has not been realized, and owing to the small size of the fields met with, the estimated out-turn of area could not be effected, notwithstanding the prolongation of the field season till the end of May. The changes in procedure delayed the progress considerably; but, apart from this cause of delay, it would have been impracticable to have completed 800 square miles which would have included about 15 lakhs of fields, with the given means. Although the area completed is smaller than that done in the previous year, there is an increase of 2¼ lakhs in the number of fields which shows the futility of attempting to make estimates for survey and *khanapuri* without some information as to the probable number of fields. The results of the season's operations show conclusively that estimates for the combined work of survey and *khanapuri* cannot be based on the number of square miles required to be taken up, for the records depend in no way whatever upon area, but upon the number of individuals whose rights in the land are to be recorded, *i.e.*, upon the number of fields. The survey is also affected by this consideration, but not to the same extent. The survey of a square mile of country containing fields averaging ⅕th acre would probably take an *amin* 2½ times as long as that of a square mile containing one acre, but the *khanapuri* would obviously take five times as long.

188. The usual checks were carried out in all branches of the work. The detail survey was tested by 2,000 linear miles of check lines, of which 365 were done by the European assistants and the *khanapuri*, by examining on the spot the entries of 3,40,347 fields, of which about 10 per cent. were tested by the Euro-

peans. The angular work of the traverses was checked by observations for azimuth taken at 70 stations, and connections have been made with 10 stations, of the Great Trigonometrical Survey. The co-ordinates of the measured traverses have been made to agree with the values obtained by the direct distances of the triangulation. The average error of the chaining in 9 cases is —2·83 feet per mile, and in one case +0·64 foot per mile.

189. In the places where the trijunctions of village boundaries were not marked with masonry platforms before the survey operations commenced, large blocks of sandstone with square tops of 12 inch sides have been embedded. Boundaries, regarding which disputes have been decided in the Civil Courts, have been marked with small masonry pillars or with blocks of stones having cylindrical tops of 6 inch diameter. The theodolite stations have also been marked with stones 2½ feet long, and 5 inch sides, the top being cut to a triangle of 4 inch sides. The number of these marks embedded during the year is 5,742, which gives an average of 6 stones per square mile.

190. The cost of the operations is given in the statement at page xxxix of the appendix. The rate per square mile for the complete operations comprising survey, records, and assessment statistics is ₹229-13-8, which is ₹58 higher than the cost rate in the Gorakhpur survey; but it must be remembered that the square mile is not the proper test of the cost of such work. As regards records and statistics, the area, as before stated, is no criterion of the work done and its cost, which depends on the number of fields, the intricacy of the tenures, the number of cultivators, &c. The comparison therefore must be made on the number of fields, and it will be seen that the rates for survey and records per field is much the same as that in Gorakhpur where the fields are larger and the rate per square mile consequently smaller. The operations of the Settlement Department have not been completed in any portion of the corresponding area, so the cost rate of the complete operations of Survey and Settlement cannot be even estimated, but it must result in a considerable reduction of cost with far superior quality of work than when the entire operations were carried out by the Settlement Department.

191. Two junior officers of the Civil Service, Messrs. J. S. Campbell and Mahomed Ishak Khan, were attached to the party for two months under the orders of the Government, North-West Provinces, for instruction in surveying, and are reported to have attained a sufficient knowledge of the various processes.

192. Owing to the shortness of the recess season, under 4½ months, the mapping could not be all completed. The cadastral survey of the season in Basti has been mapped in 1,402 sheets on the 16 inch scale, and the Gogra river survey in 8 sheets on the 4 inch scale, but they have not yet been submitted. During the year, 67 despatches of maps have been made to the Head-quarters office, comprising 773 sheets. The topographical maps of districts Ghazipur, Ballia, and Benares had to be retained in the field office, but it was hoped that they would be shortly ready for despatch to Calcutta; they include 46 quarter sheets of the standard size, drawn on the 2 inch scale for reduction to 1 inch, and 42 original and 40 fair sheets to margin, on the 4 inch scale, of the Ganges and Gogra Deara survey.

193. Receipts in duplicate have been taken for all records supplied to the Civil authorities, to whom 311 despatches have been made during the year. These include maps and *khasras* of 2,065 villages, containing 10,27,609 fields and 696·84 square miles.

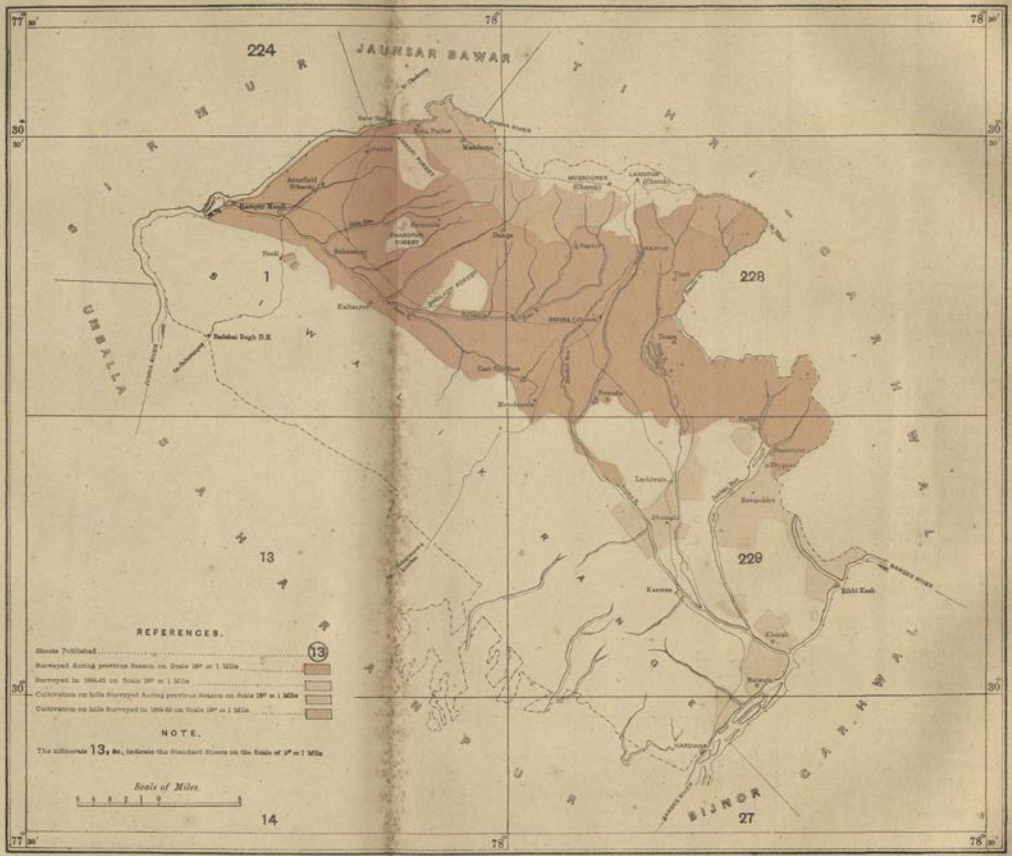
194. The approximate area remaining for cadastral survey in the Basti district is 2,037 square miles, in which, from the returns obtainable through the *tahsils*, it appears probable that the number of fields may be about 40 lakhs, so that the annual out-turn measured in square miles will necessarily be small. In order, therefore, to complete the district, as required by the Government in 1887-88, a large increase to the field establishments will be necessary. This has been arranged for the current season by an additional grant of money obtained from the Settlement budget, and it is hoped that the programme which has been made for the completion of the district within the stipulated time may be successfully carried out, but the undertaking will be one of considerable labour and anxiety.

195. Major Cowan reports that the new Settlement Officer, Mr. Hooper, has

N. W. PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY OF DEHRA DUN.

DETACHT. No. 3 REV. PARTY.


224
JAUNSAR BAWAR
228
229
1
13
14
27
SIRMUR
UMBALLA
SAHARANPUR
GARHWAL
BIJNOR
Kalsi
Kulhalgarh
Rajpur
Mussoorie
Landour
Dehra
Lachiwala
Kanwa
Bhogpur
Rikhi Kesh
Hardwar
Ganges River
Jumna River
Tons River
Asan River
Suswa River
Song River
Rispana River
Bindal River
Rajpur Road
Mussoorie Road
Hardwar Road
Kalsi Road
Chakrata Road
Simla Road
Kulhalgarh Road
Bindal Bagh D.B.
Kanwa Mandi
Champion Forest
Kulhalgarh Forest
Rajpur Forest
Sirmur Forest
Mussoorie (Church)
Landour (Church)
Dehra (Church)
Kalsi (Church)
Hardwar (Church)
Rikhi Kesh (Church)
Lachiwala (Church)
Kanwa (Church)
Rajpur (Church)
Bhogpur (Church)
Simla (Church)
Chakrata (Church)
Kulhalgarh (Church)
Pinoli
Kalsi
Kulhalgarh
Rajpur
Mussoorie
Landour
Dehra
Lachiwala
Kanwa
Bhogpur
Rikhi Kesh
Hardwar
Chakrata
Simla
Kulhalgarh

rendered most active assistance to the Survey Department, and that the arrangements that he has made for furthering the work during the coming season are all that could be desired. The Deputy Collectors have all been anxious to assist, and the hearty co-operation of Baboo Uma Shankar, M.A., is brought prominently to notice.*

DEHRA DUN DISTRICT, NORTH-WEST PROVINCES.

(DETACHMENT FROM NO. 4 PARTY, REVENUE BRANCH.)

196. This detachment has continued under the charge of Mr. W. A. Wilson, but has been generally superintended by Major E. H. Steel. The portion of country which remained to be surveyed lay in the Eastern Dun. Field operations commenced on 1st November 1884, and were continued till 1st April 1885, when the survey was completed.

Personnel.
Mr. W. A. Wilson, Surveyor, 2nd grade, in charge.
Mr. F. E. Warde, Assistant Surveyor, 3rd grade, up to 1st March 1885.
2 Sub-Surveyors.
Temporary Establishment.
50 Field Surveyors and others.

197. The season's out-turn comprises an area of 120 square miles of Cadastral survey on the 16 inch scale, in which there were 21,497 fields, having an average size of 1·87 of an acre. The large mahal of Malkot has been divided into 24 separate mouzas and their boundaries surveyed and mapped. The additional work of writing the village *khasras* has again been carried out by the Survey establishment on the same system as explained in paragraph 159, Part II of the last Annual Report.

198. The preliminary traverse work had been executed during the previous season, but the work in some of the villages on the lower hills where the ground was very broken, rugged and unsuited for chain measurements, was found not to close within the usual limit of error allowed and had to be re-surveyed. Thirty villages in the Eastern Dun had also to be re-traversed, due to the stations of the previous year having been carried away by rivers. Owing to the rapid growth of vegetation in this part of the Dun, all the lines of the traverses prepared in the previous season had to be re-cleared.

199. Much work of a miscellaneous nature has also been done, such as re-surveying boundaries which had been altered by the settlement of disputes, amalgamating separate mouzas which had been formed into one, separating others which were one at the time of survey, into two or more, and correcting maps and documents according to the requisitions of the Settlement Department.

200. The same difficulties were met with in regard to the nature of the country operated in, as were reported in paragraphs 160 and 161 of the previous report. The survey of the cultivation in the hill villages was tedious and expensive, both on account of the minuteness of the fields, which averaged only 0·30 of an acre, and of the extent of country which it was necessary to work over, to fix the positions of these detached portions and to supply the necessary working points to base the survey on.

201. The field measurements were tested by 38 linear miles of check survey run by the native inspectors, and in addition each field surveyor was inspected by the officer in charge and his work examined on the spot.

202. The total area which has been surveyed cadastrally in the district in the two seasons amounts to 389 square miles, comprising 459 villages, which have been mapped on 718 sheets and submitted to the Calcutta office for reproduction by photo-zincography. Traces of the same in duplicate have also been prepared and furnished to the Settlement Officer.

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* Major Cowan highly commends the services of Messrs. Hanby and Price, in charge of the cadastral camps, who by their energy and careful management effected a large out-turn of good work under very trying circumstances.
The other assistants are reported on as follows:—

"Mr. Pemberton held charge of the traverse camp, the out-turn of which is very large.
"Mr. Hill did excellent work in the field season.
"Mr. L. F. Berkeley has acquired a thorough knowledge of *khanapuri* and is now a very valuable assistant in either a cadastral or traverse camp. Messrs. Hughes and Johnson have performed their duties satisfactorily."

Of the Native Establishment the following men are brought prominently to notice:—Jamaludin, Lalmohun Gangopadhya, Mir Asjad Ali, and the writer, Ibu Hasan.

203. The work of this detachment having been completed, the establishment has been absorbed into other field parties.*

GORAKHPUR DISTRICT, NORTH-WEST PROVINCES.

(No. 5 Party, Revenue Branch.)

204. The field operations of this party were resumed on 23rd October 1884 and carried on, until 30th April 1885, under the charge of Major Sandeman who has continued to superintend the joint operation of survey and preparation of settlement records in the Gorakhpur district during the year under report. The cadastral survey has been carried out entirely on the 16 inch scale. The party has also continued and completed the survey on the 4 inch scale of the riverain villages on the right bank of the Gogra river in the Azamgarh and Faizabad districts, adjoining the Gorakhpur district.

Personnel.

Major J. E. Sandeman, S.C., Officiating Deputy Superintendent, 2nd grade, in charge.
Lieutenant F. B. Longe, R.E., Assistant Superintendent, 1st grade, up to 17th January 1885.
Mr. E. G. Little, Surveyor, 3rd grade.
" F. F. Freeman, Assistant Surveyor, 1st grade.
" T. Shaw, ditto, 1st ditto.
" J. Murphy, ditto, 1st ditto.
" O. D. Smart, ditto, 2nd ditto.
" N. Bedford, ditto, 3rd ditto.
" F. E. Warde, ditto, 3rd ditto, from 1st March 1885.
17 Sub-Surveyors and others.

Temporary Establishment.

246 Field Surveyors and others.

The areas accomplished are shown in the following statement:—

District.	Tahsil.	Description and scale of survey.	Number of villages.	Area in square miles.
Gorakhpur	Bánsgaon	Cadastral; 16 inch.	1,645	449·37
Ditto	Hata	Ditto	538	298·00
Total of Cadastral Survey	.....	.....	2,183	747·37
Azamgarh	.....	Mouzawar; 4 inch.	110	92·00

205. The unit of survey was the field of which the ownership and the occupancy is separate: cultivation ridges or *kiaris* have been omitted, but partitioned fields, whenever the location and direction of the shares could be ascertained, have been mapped, as well as those partitions, when cultivators sharing in common, desired to separate their shares and agreed to a division.

206. In the cadastral area, the number of fields surveyed amounted to 899,793, having an average area of 0·53 of an acre. Preliminary traversing in advance for the cadastral survey of next season has been carried out over an area of 533 square miles.

207. During the year 1883-84 the basis of the system under which the record-of-rights was prepared jointly by the Survey and Settlement Departments was as follows:—

The Survey Department furnished an accurate record of all undisputed entries, together with a complete list of all disputes, and it also classified the soils. The Settlement Department filled up the dispute list, and checked the soil demarcation. From the experience then gained, it was considered advisable to make considerable modifications in the procedure for the year under review. The revised rules for the working of the two Departments in 1884-85 were published in the last Annual Report at pages cxxxi to cxxxiii of the appendix. The principal changes were as follows: that (1) whereas the Survey Department left disputed entries blank to be filled in by a dispute *munsarim*, there are now no blank entries left, all disputes are entered in red ink by the *amins* and the patwari is responsible for them; (2) the demarcation of soils, both natural and conventional, has been made over entirely to the Survey Department.

208. Regarding these changes Major Sandeman reports as follows:—

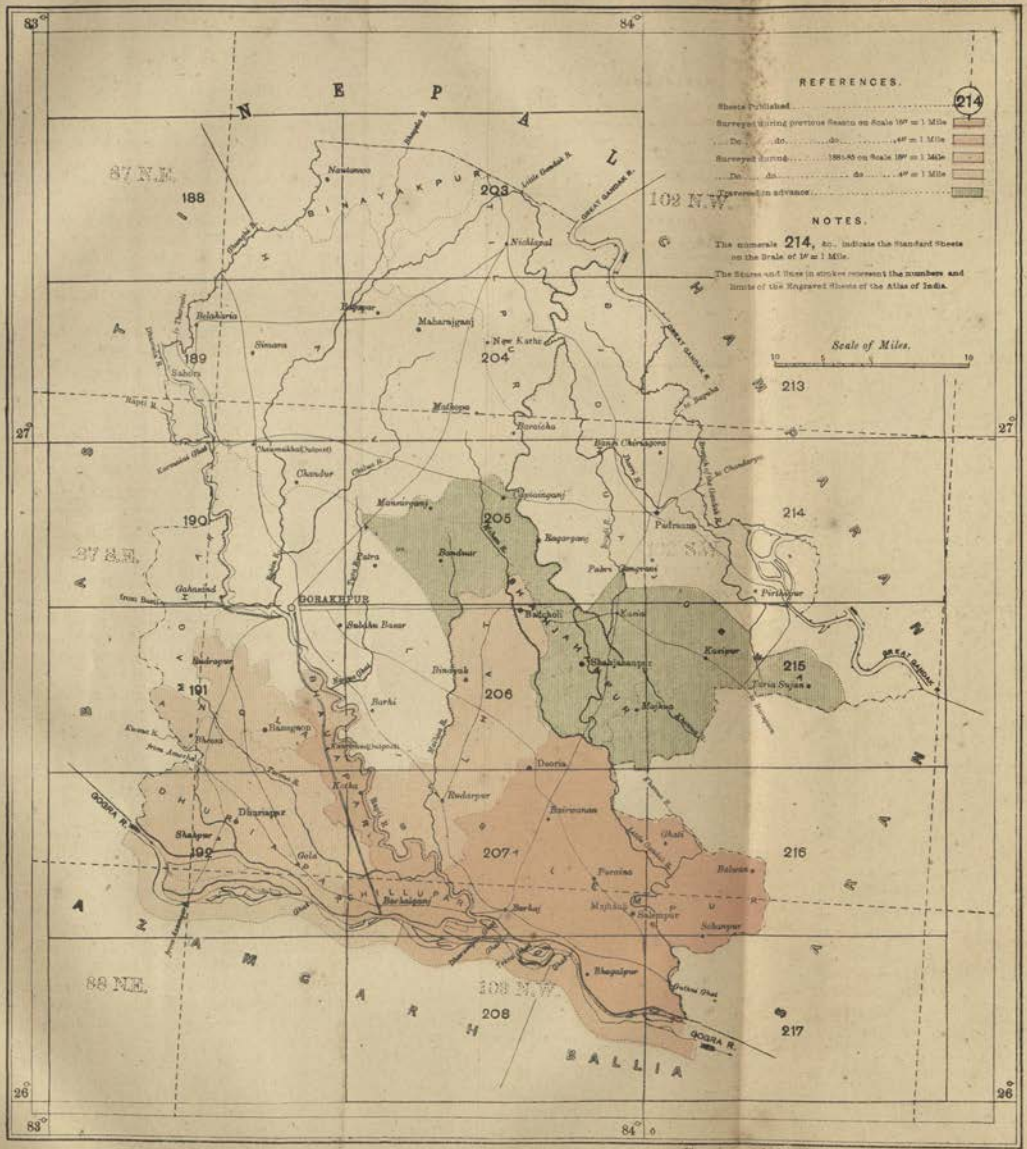
"The disputed entries have been filled up in the *khasras* and *jamabandi* slips in red

* Major Steel reports as follows: "Mr. W. A. Wilson has, in my opinion, done a difficult piece of work in a satisfactory manner; he has had many difficulties to overcome, especially in the hill survey, and he deserves great credit for his efforts."

N. W. PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY OF DISTRICT GORAKHPUR.

No. 5 REV. PARTY.



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Survey of India Offices, Calcutta, November

1885.

under certain fixed rules by the survey *amins*, at the time of *khanapuri*. These rules do not leave any discretion to the *amins*, and under them the entries in red are those which are *primâ facie* correct. *Sir* claims are checked by an abstract from the patwari's papers prepared for the purpose. Except in cases of *sir* claims, whatever the interested parties agree in stating is entered, unless there is reason to believe that through intimidation a tenant does not claim occupancy right, when reference is made to the papers of 12 years ago. In cases of dispute, the name of the person whom the patwari states is in possession is written, except when the dispute is with reference to the tenant having occupancy right, when the papers of 12 years ago are referred to.

"The above rules obviate references to the patwari's papers, which are found to contain many inaccurate entries, except in those cases when they must be referred to at attestation for proofs of length of occupancy, &c. The entries being so far completed at *khanapuri*, statistics for assessment purposes can be extracted at once. Rent disputes are still left blank till attestation, to be filled in by the Deputy Collector.

"Entire responsibility for the demarcation of natural and conventional classes of soil has been entrusted to the Department. There is little difficulty in distinguishing the former; the demarcation of the latter has been in accordance with that which is locally recognized as affecting rents, and when differential rates did not prevail by which an *amin* could be guided, careful enquiry revealed to which tracts the cultivator's field belonged."

209. These changes in the procedure threw extra work on the Survey Department and the references to the patwari's papers have caused delay in the progress, but the Deputy Superintendent is of opinion that these modifications have made a better division of labour between the two Departments, and the record is made over in a far more complete manner than before.

210. The boundary disputes were very numerous; no less than 1,800 of the villages surveyed were affected thereby. They appear to have been due to defective field maps, adjoining maps invariably overlapping each other, and thus the same ground appears in both. This has been the cause of much litigation and ill-feeling among the neighbouring zamindars. In order to lessen disputes, many of which are raised in the interval between the skeleton traverse and the field surveys, the village boundaries are now being finally laid down at the time of the traverse survey when the demarcation has just taken place.

211. The complete record now sent to the Settlement Department consists of (1) two soil traces (in Urdu and Nagri); (2) two *khasras* (in Urdu and Nagri); (3) two dispute lists (in Urdu and Nagri); (4) the slips arranged by tenures and holdings; (5) the *terij* or abstract of slips; (6) the *khewat* (obtained from the patwari); (7) assessment statistics (areas classified under soils, castes, crops, &c.); (8) *tappawar* abstract of all statistics; (9) pargana soil map.

212. In the extract from Major Sandeman's report for 1883-84, printed at page xxii of the appendix of the last Annual Report, some of the most important statistics of the Deoria *tahsil* were given; these have now been supplemented by those of the Bánsgaon *tahsil*, which will be found at page xxxvi of the appendix. Besides conveying useful information, they illustrate the extent of the work that has been furnished by the Survey Department and their accuracy may be relied on.

213. The theodolite traverse stations have all been permanently marked: stones similar to those used last year have been embedded at 3,500 stations, and clay cylinders at 1,700 other ones, making the average number of marked points about 6 per square mile.

214. The cost-rates of the season's work for each separate class of the operations of cadastral survey and records are as follow:—

	Per square mile.			Per square mile.		
Survey—	*R*	*a.*	*p.*	*R*	*a.*	*p.*
Permanent marks	9	12	3			
Traversing	16	12	10			
Field survey, 16 inch scale, including preparation of the village maps for reproduction	66	5	8			
				92	14	9
Records—						
Record-writing (khanapuri)	34	5	5			
Completion of *parcha jamabandis*, Nagri *khasras*, *terijs*, soil maps and statistics for assessment	43	13	10			
				78	3	3
				171	2	0

215. This represents the expenditure per square mile of the total operations done by the Survey Department, which is equivalent to 4 annas 3 pies per acre. The corresponding rate for the previous year was 4 annas and 6 pies; so that notwithstanding the retarding influences due to the change in procedure regarding disputed entries, which necessitated a reference to the old record, there has been a still further diminution in the cost this year.

216. The rate now obtained for all these operations compares very favourably with the old rate for field survey alone. This is not due to larger fields, for the average size of the fields met with in Gorakhpur is only half an acre, but it proves what Survey officers have always urged, that the work would not only be much better done but more cheaply, if the Survey Department were allowed to record the rights of the proprietors and tenants at the time of survey, for it has been conclusively proved that correct field boundaries cannot be obtained otherwise, as the people will not attend unless they know that their rights are being recorded.

217. The expenditure of the Settlement Department for their share of the operations has been obtained from the Settlement Officer for one *tahsil* and amounts to ₹239-3-2, which is much higher than was anticipated. The letter from the Settlement Officer, No. 518, dated 6th January 1886, on this subject, will be found at page xxxix of the appendix, in which he shows that the high rates are in a measure exceptional, and also a letter from Major Sandeman, the Deputy Superintendent in charge of the Survey, No. 10, dated 11th January 1886, on the same subject, pointing out that there are many local causes which have tended to raise the cost of the settlement charges so far. The complicated tenures, minute holdings and the great number of disputes due to the existing maps being of a very inferior description, has rendered the work of attestation and assessment one of great labour. The total cost of the complete operations thus amounts to ₹410 per square mile.

218. As regards the charges of the Survey Department under the different heads, Major Sandeman maintains that the various descriptions of work could not have been done cheaper under any other supervising agency, and it will be admitted that the rates are low. The question, therefore, arises that as the settlement charges are so high, when such a large extent of their ordinary work is supplied to them by the Survey Department, what would the cost have been without this aid? It must be acknowledged that it is not due to the employment of the Survey Department that the charge of the complete operations so far is high. But the settlement cost, as given above, is not a fair criterion of what the average rate will be over the whole district. The system must still be considered to be in an experimental stage; further changes and reforms have been recommended for the work of the current year, the principal one of which is the more liberal employment of the district staffs by the Settlement Department, which will all tend to greater economy, and it may be confidently expected as the operations proceed, that the cost of the combined operations will be lessened. In testimony of the appreciation of the services of the Survey Department by the Revenue authorities in Gorakhpur and of the economy that is effected by its employment in conjunction with the Settlement Department, a letter No. 540, dated 10th February 1886, from the Settlement Officer to the Commissioner, Benares Division, is given at page xli of the appendix.

219. The check surveys to verify the accuracy of the field measurements aggregated 2,020 linear miles, and the survey has been passed on its agreement with independent *partal* lines. The work is said to have stood the tests well. As checks on the angular work of the traverse survey, observations for azimuth were taken at 62 stations. The traverses have been connected with two trigonometrical stations and the co-ordinates of the measured traverses have been made to agree with the values obtained from the direct distances of the triangulation. The average error of the chaining is 2·05 feet per mile. The records underwent the usual checks in the field, 20 per cent. were examined by *munsarims* and 5 per cent. by the European assistants aided by head *munsarims*.

220. The disputes referred to in paragraph 178 of last year's report, regarding the boundaries of Gorakhpur with the Sarun district, have been settled, an agreement having been arrived at between the Governments of the North-Western Provinces and Bengal, but similar trouble is anticipated along the remainder of the boundary conterminous with Bengal. The boundary on the Gogra river

with the districts of Azamgarh and Ballia has also been decided. On these points Major Sandeman reports as follows:—

"The disputes raised by the Raja of Hatwa have all been disposed of; most of his claims have been disallowed on the faith of maps prepared in the Survey Office, which showed side by side the boundaries of the year 1836 and those now surveyed. In many cases it was proved that the Bengal zamindars, while claiming more land than they then possessed, had actually encroached beyond their proper limits. It has been decided that the deep stream is the legal boundary on the Gogra river between the Gorakhpur district on the one side and the districts of Ballia and Azamgarh on the other."

221. In consequence of the many changes that had taken place in both the field and office procedure for the combined operations of Survey and Settlement since the publication of Major Barron's hand-book in 1883, a revised edition has been prepared during the recess by a committee of which Major Sandeman was President and Major Cowan in charge of the Basti survey and Messrs. Little and Hanby, Surveyors, were members. The work has been brought up to date to accord with the present procedure. In compiling this edition the opinions of several Settlement Officers of the North-Western Provinces have been obtained, and it now forms a complete guide to the combined system as adopted in the North-Western Provinces.

222. Three Junior Civilians, Messrs. Holms, Forbes, and Partridge, were attached to the party for two months during the field season for instruction in surveying. The Deputy Superintendent states that this duty is a considerable tax on his time at that busy season of the year, and considers that the pupils would learn more if attached to the party during the recess season, when more time could be devoted to them.

223. At the request of the Board of Revenue, North-Western Provinces, Major Sandeman was deputed towards the end of the field season to demarcate a portion of the Rámpur State boundary adjoining certain villages in the Moradabad and Tarái districts. The preliminary inspection of the ground was made in March 1885, and when the survey of the existing course of the river Kosi was completed and combined with the maps of 1872 to 1875, the demarcation was carried out in May 1885. The report on this demarcation has been submitted to the local authorities.

224. The cadastral survey has been mapped in 1,745 sheets on the 16 inch scale. A separate series of sheets on the 4 inch scale of the Gogra river survey is under preparation. The sites of many submerged villages, the rights in which lie dormant, will be shown on these maps, so that they may be useful to settle any claims which may be made when lands form again. The 2 inch standard maps of the Mirzapur district reduced from the cadastral survey have been completed, numbering 31 maps, and despatched to Calcutta. The records submitted to the Settlement Officer for attestation are those of the Bánsgaon *tahsil* and part of the Hata *tahsil*, in which there are 2,581 villages, containing 10,19,469 fields.

225. The success that has thus been obtained in the new system of combined operations of Survey and Settlement, which admits of the record being prepared and attested in the same year, is mainly due to the energy and zeal of Major Sandeman, who has devoted himself to its development and to the economical working thereof, and the Government of India has already conveyed to him their appreciation of the trouble he has taken to investigate the important question of the cost of cadastral operations.

226. Major Sandeman again acknowledges the valuable assistance rendered by Mr. LaTouche, the Settlement Officer, whose co-operation and interest in the success of the work have been most thorough.*

.* Major Sandeman reports on the services of his assistants as follows:—

"Lieutenant Longe, R.E., shewed great interest in his new duties, and it was unfortunate that the necessity for his transfer arose, just as he was beginning to gain some knowledge of them. Messrs. Little and Shaw, in charge of the cadastral camps, have supervised their work most satisfactorily. Mr. Freeman, in charge of the traverse camp, has done the same and now succeeds Mr. Shaw in charge of a cadastral camp. Messrs. Murphy, Smart, and Bedford have all done well.

"The following members of the Native establishment are deserving of mention:—Puran Chand, Babu Ram, Jairam Sing, Waris Ali, Lalji Mal, Nidha Lal, Golamjous, Joala Persad and Ganga Persad of the permanent establishment; and Amanat Hosein, Shib Sahai, Har Sahai, Kali Churn, Abdul Hamid, Jainarain, Dhanpatrai, Bhajan Lal, Kalka Pershad, Majibulla and Mumtaz Ali of the temporary establishment."

KAMRUP DISTRICT, ASSAM.

(No. 6 PARTY, REVENUE BRANCH.)

227. This party, which has remained throughout the year under the charge of Mr. E. C. Barrett, left its recess quarters, Shillong, on 27th October 1884, for Gauháti, where the field establishments were organised. Field operations were resumed in the Kámrúp district on the 10th November 1884 and were continued until the 6th May 1885.

Personnel.

Mr. E. C. Barrett, Deputy Superintendent, 4th grade, in charge.
Mr. J. H. O'Donel, Surveyor, 4th grade.
„ D. A. King, ditto 4th grade.
„ J. Connor, ditto 4th grade.
„ C. S. Kraal, Assistant Surveyor, 2nd grade.
„ J. C. Kelly, ditto 2nd grade.
„ J. Smith, ditto 3rd grade.
27 Sub-Surveyors and others.

Temporary Establishment.

149 Field Surveyors and others.

Cadastral operations were confined to the right bank of the Brahmaputra river. The area that has been surveyed cadastrally on the 16 inch scale is 478·05 square miles, containing 400 villages and comprising 287,169 fields, the average size of which is 1·06 acre.

228. The system of survey carried out was identical with that adopted last year, the unit of measurement being all contiguous blocks of the same class of land owned by the same individual. *Khasras, i.e.*, records of rights, soils, agricultural statistics, &c., have been written up in the field by the *amins*, while independent registers (*Dag Chittas*) were made by the *Mandals*, or village officials.

229. The preliminary boundary traversing of a further area of 772 square miles has been also completed in readiness for the cadastral work of the next season. Six stations of the Great Trigonometrical Survey have been incorporated with the measured traverses, and the values of the direct triangulation rays have been used for correcting the chain measurements; the average of the corrections that were applied is 2·44 feet per mile. The angular work has been checked by azimuth observations taken at 40 stations.

230. The Cadastral Survey has been rigorously tested in all stages of progress; 278 linear miles of check survey were run through the work by European assistants and 803 linear miles by inspectors. The European officers, moreover, paid 515 inspection visits to *amins* in the field, during which the accuracy of the *khasra* entries was chiefly attended to. The Sub-Deputy Collectors of Settlement, one of whom was attached to each Cadastral Camp, also tested and initialed not less than 10 per cent. of the *khasra* entries of each village.

231. The completed area contains 73 *lakhiraj* (rent-free) estates, having an area of 16,717·35 acres; 934 *nisf-khiraj* (paying half rent) estates, with an area of 62,994·69 acres, and 3 waste land grants covering 899·83 acres. The total area of lands held rent-free or at privileged rates is thus 80,611·87 acres (about 126 square miles) or 26 per cent. of the area surveyed.

232. Mr. Barrett reports that, owing to the general unhealthiness of the Assam Valley, great difficulty was experienced in bringing the field establishment up to the required strength, only 40 per cent. of the field surveyors who were granted leave during the previous year returned to duty, which necessitated the employment of new hands who had to be trained to the system of survey and record-writing required in Assam. Of 97 tindals and measurers sent on leave at the end of the previous season only 24 rejoined; the offer of double the wages usually paid in the North-West Provinces failed to induce the large majority of men to brave the climate of Assam with its attendant sickness and discomfort.

233. The revision survey, by which must be understood the enquiry into and settlement of objections raised by tenure-holders, on the distribution of the *jamabandi* slips (the separate statement of fields held by each cultivator), of the work of season 1883-84, was completed on the 1st February 1885 by the Settlement and Survey Officers conjointly. The last batch of revised maps was forwarded from the field to the head-quarters office at Calcutta on 17th April 1885. The Deputy Commissioner of Kámrúp has been furnished with 50 copies of each map for settlement purposes. It is satisfactory to learn that

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY OF DISTRICT KAMRUP.

No. 6 REV. PARTY.

Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, R.E., Surveyor General of India.

Survey of India Offices, Calcutta, November 1885

the revenue assessment for 1885-86 of the area completed during the year of survey is based on the revised survey results.

234. The Cadastral Survey done during the season has been mapped on sheets on the 16 inch scale for reproduction. The Settlement Officer has been furnished with tracings from these maps and with the village *khasras* of the entire season's work.

235. The cost-rates of the season's operations will be found in the usual statement in the appendix. Considering the difficulties peculiar to the country they bear favourable comparison with rates in other provinces. The rates for the following descriptions of work done by the Survey Department are as follow:—

	R	a.	p.	
Traversing	31	12	11	per square mile.
Detail survey 16 inch scale	92	12	7	ditto.
Records (*Khanapuri*)	42	12	9	ditto.
Completion of records	48	5	0	ditto.
Revision survey	5	0	1	ditto.
TOTAL	220	11	4	

The expenditure incurred by the Settlement Department over the same area amounts to R23,498, which gives a cost rate of R49-2-6 per square mile, so that the total cost rate of the combined operations is R269-13-10 per square mile, or 6 annas 9 pies per acre. The rate for the Revision Survey, R5-0-1 given above, is for the area executed during the previous year, but that rate may safely be taken for the area of the present season, and the low rate for the combined operations is an encouraging proof of the economical merits of the system, which is the only point on which critics have been doubtful, as well as its acknowledged superiority in accuracy. The system of land tenure is *ryotwari*, the attestation of the records, therefore, is very simple and disputes few.

236. Owing to financial difficulties, the Government of India has directed that the expenditure on the Kámrúp Survey during the financial year 1885-86 must be restricted to one lakh of rupees. The heavy reduction of field establishments that this order renders necessary will have a very injurious effect on the out-turn of the party, whereby the cost-rates of the work must be considerably enhanced. The area prepared in advance for the current season's operations covers 772 square miles; but in consequence of this reduction, it is estimated that not more than 375 square miles can be surveyed in detail. The excess area of preliminary traverse survey will unfortunately be wasted, as the continuance of cadastral operations in the Kámrúp district beyond the current season is not contemplated by the Assam Administration.

237. Boundary traverse survey in advance for cadastral operations in season 1886-87 will be started during the current field season in the Mangaldai subdivision of the Darrang district, the survey of which has been authorized by the Chief Commissioner of Assam.

238. Mr. Barrett acknowledges the valuable assistance rendered by Mr. H. Z. Darrah, Director of Agriculture, whose co-operation with the Survey Department would seem to have been cordial and complete, and the support of the Deputy Commissioner, Mr. A. C. Campbell, whose personal influence in the district, it is stated, has been always exercised in behalf of the survey.*

* Mr. Barrett reports very favourably of Mr. O'Donel, who held charge of a cadastral camp, and of Mr. Connor who supervised the traverse camp. Mr. King, who had charge of the second cadastral camp, is also well reported on as regards his qualifications and diligence, but he suffered from bad health. Messrs. Kraal, Kelly, and Smith are reported to be hard-working and very willing assistants, who have given satisfaction during the field and recess seasons. The following sub-surveyors are specially mentioned:—Mohan Sing, Tajjuddin, Sakhawat Hosein, Sarada Prosad Chakrabatty, Gunga Ram, and Janardhan Rao, Babu Sitanath Chakrabatty, and Beni Ram, Jhumni Lail and Harakuarain of the temporary establishment are brought to favourable notice.

PUNJAB PROVINCE SURVEY.

(No. 1 Party, Revenue Branch.)

239. During the year under report, a new departure was ordered for the operations of this party in the Punjab. The objects of the survey operations were (1) to furnish a basis for and a check on the patwari measurements under progress in the Sub-Himalayan districts of the Punjab; (2) to obtain a new and revised series of the existing topographical maps which are very old and deficient in details, by utilizing the settlement maps prepared by the patwaris; (3) the survey of all the riverain tracts which are subject to fluvial action. Sanction for the above operations was received from the Government of India, Revenue and Agricultural Department, in their letter No. $\frac{586}{102\cdot4}$ S., dated 8th October 1884.

Personnel.
Lieutenant-Colonel F. Coddington, Deputy Superintendent, 2nd grade, in charge.
J. Todd, Surveyor, 2nd grade.
W. S. Buttress, Surveyor, 3rd grade.
C. W. Wilson, Assistant Surveyor, 1st grade.
G. Campbell, " "
E. B. M. Drew, " 2nd grade up to 18th April 1885.
J. P. Barker, Assistant Surveyor, 3rd grade.
Sub-Surveyors and others.

240. The recess work of the Hissar Survey on which this party had been previously employed was completed at Murree on 13th October 1884, when Colonel Coddington proceeded to Rawal Pindi to arrange, in consultation with Colonel Wace, 2nd Financial Commissioner to the Punjab Government, the programme of field work. The procedure agreed upon was briefly this—(*a*) that in those districts which have recently been surveyed by the patwari agency, an attempt should be made to construct topographical maps from the patwari maps, on the basis of the old professional survey traverse data; (*b*) that in districts in which the patwari survey had not yet been made, skeleton traverses are to be run, fixing as a minimum two points in each village to serve as checks on the patwari measurements and as a basis on which the topographical maps could be framed from the patwari maps when constructed; (*c*) that the topographical maps so compiled are to be locally tested and the details corrected and completed where necessary.

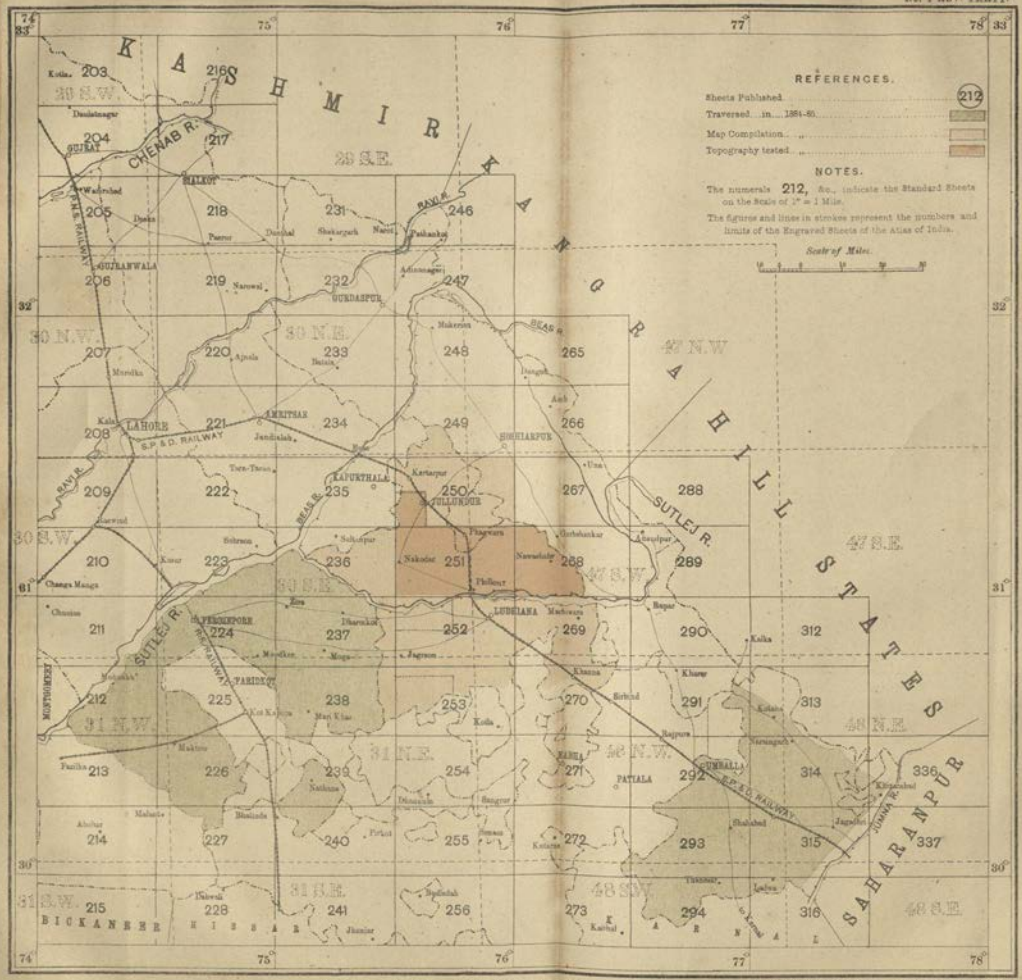
241. Field operations were commenced on 21st October 1884, and continued till the 30th April 1885. The traverse survey of district Ferozepore, as well as about two-thirds of district Umballa, has been completed. In the case of Ferozepore, a minimum of two points has been fixed per village, but in Umballa all the village trijunction points have been traversed, as it was found that the reductions from the compilation of the patwari maps could not be satisfactorily carried out unless these points were fixed. Simultaneously with the commencement of work in Ferozepore, the compilation of the patwari maps of the Jullundur district on the 2 inch scale was attempted on the basis of the old traverse survey data; this, however, proved a failure, and a limited amount of new traverse work was found to be imperative. An area of 792 square miles has been finally completed and mapped on the 2 inch scale; this comprised the reduction from the patwari maps by pentagraph and the local test of the topographical details. The chief items that were found wanting and which have been inserted at the time of test were high banks, bridges, mile stones and correct limits of village sites. During the year an additional area of 1,858 square miles has been reduced and compiled ready for test in the current season. The following table exhibits the separate areas in the different districts:—

District.	Area reduced by pentagraph from patwari maps, in square miles.	Area tested and mapped, in square miles.
Jullundur	1,336	754
Kapurthala State	114	38
Ludhiana	1,200	...
Total	2,650	792

PUNJAB SURVEY

INDEX TO THE SURVEY OPERATIONS IN THE PUNJAB.

No. 1 REV. PARTY.



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Survey of India Offices, Calcutta, February

1886

Photozincographed at the Survey of India Offices, Calcutta.

A survey on the 16 inch scale was also made of the Government c[illegible] farm at Karnal, comprising an area of about 4 square miles. This was d[illegible] to meet the requirements of the Commissary General. The survey has [illegible] mapped on four sections for reproduction.

242. A portion of the boundary between the Shahpur and Jhelum d[illegible] about 4 miles in length, in which there had been a long-standing dispu[illegible] demarcated in accordance with the former survey at the request of the Fi[illegible] Commissioner. An area of about 3 square miles of contiguous countr[illegible] surveyed on the 4 inch scale at the same time.

243. With regard to the traverse survey, as areas were not requi[illegible] the Settlement Department, the ordinary system of surveying by circuit[illegible] not followed. The country operated in was conveniently covered with st[illegible] of the Great Trigonometrical Survey, and the main traverses were carried be[illegible] these fixed points. They aggregate in length 2,329 linear miles, and the[illegible] verse distances agree well with the triangulation distances. The compa[illegible] between the triangulation distances and the traverse distances shows that [illegible] measurements have been carefully made; the average error of the chain[illegible] was found to be 2·3 feet per mile. From the basis of these main traverses, sub-tr[illegible] verses, aggregating 3,950 linear miles, have been carried across the country [illegible] connecting on secondary triangulated points and arranged at certain distances [illegible] apart so as to secure the necessary number of fixed points in each village. Offsets were recorded in field books to all permanent objects falling near the chain lines, which afford an additional basis for reducing the patwari maps, as well as checks on the measurements thereof.

244. Observations for azimuth were taken at 127 stations as checks on the angular measurements of the traverses. The out-turn of topography was checked by 939 linear miles of plane-table survey in which all the deficiencies that were found were supplied.

245. The country operated in is for the most part highly cultivated and open and offered no great obstacles to the progress of the survey. The overflow from the Sutlej river forms large alluvial tracts, locally known as *Bet*; in some of these lands, a tall coarse grass grows which required to be cleared for the traverse lines.

246. In the Ferozepore district, where only a limited number of trijunction marks of villages were fixed, the intermediate traverse stations, 2,352 in number, have been marked with concrete blocks at a cost of R2,471, including construction, carriage, and embedding. In the other districts where all the trijunction marks have been made into traverse stations, no other permanent marks were necessary.

247. The reduction of the patwaris' maps from the scale of survey, which varied between 27 inches and 16 inches to the mile, has been a very important part of the year's operations and has proved a laborious and difficult process. There was much time lost in experimenting with these maps, the details of which will be found at page xliii of the appendix, extracted from Colonel Coddington's report. The experience gained from the maps of Jullundur, which were first taken in hand, proved that a larger number of fixed traverse points than had been first decided on was absolutely necessary to overcome the inaccuracies of the patwari maps and to avoid the difficulties that had been met with in constructing the 2 inch maps therefrom. It was then determined with the concurrence of the Financial Commissioner that in future traverse work in other districts all the trijunction marks of villages are to be fixed, and Colonel Coddington anticipates that with this increased number of common fixed points in each village, many of the difficulties of incorporating the details of the patwari survey into topographical maps will vanish. This operation is purely an office one, and if orders for the employment of the party had been communicated earlier, much of this work could have been prepared during the previous recess season, which would have enabled a far larger area of country to be tested and mapped.

248. The result of the year's experiment shows that the patwari maps of the settlement survey are capable of being utilized for the construction of topographical maps on a small scale, when based on a scientific framework comprising all the trijunction marks of villages. The errors of survey are not greater than are found to become eliminated in the process of reduction.

249. The cost rates of the operations are as follows: in Jullundur and Ludhiana districts, the cost rate of traverse survey is ₹4-3-7 per square mile; the cost of compilation of patwari maps, the local test and the fair mapping on 2 sheets is ₹14-3-11, so that the total rate for traverse and topography amounts to ₹18-7-6, or about two-thirds of the cost of a new topographical survey. The operations will in the future be more costly (those in Ferozepore and Gurdaspur costing ₹7-15-7 per square mile) as they are to be of a more elaborate character, embracing all the trijunction marks, yet Colonel Coddington hopes that the total rate will be reduced as low as ₹15 per square mile. If this expectation is realised, the cost of these operations will be about one-half of that which would be involved in a fresh survey.

250. The present procedure therefore promises to be both economical and of mutual advantage to both the Imperial and Provincial Surveys, (1) in securing new topographical maps of the Punjab province at a very moderate outlay; (2) in supplying an accurate framework on which the patwari measurements may be based. Hitherto the skeleton traverse provided by the professional survey has been utilized merely to check the patwari maps after completion of survey, but it has been now arranged, subject to the concurrence of the Lieutenant-Governor of the Punjab, that in future when the professional survey precedes the patwari survey, the framework provided by the former shall be utilized to form the basis of the latter.

251. The settlement maps that have been made use of up to the present time have been surveyed on the ordinary procedure of such surveys. A new system has, however, been introduced lately for carrying out these surveys in the Punjab, designated the "square" system, which is reported to have improved the accuracy of the maps made by the patwaris, but maps surveyed on this principle have not yet been tested.

252. The organisation of this new undertaking has entailed much care and trouble, and the out-turn of work that has been obtained in the first year of the operations is very creditable to Colonel Coddington and his assistants. The Punjab Government has expressed great satisfaction with the progress of the work.

253. The operations in the current season will be continued in the districts of Jullundur, Ludhiana, and Umballa and in the Kapurthala State and extended into the districts of Gurdaspur and Hoshiarpur.*

CHHATTISGARH DIVISION, SAMBALPUR DISTRICT, CENTRAL PROVINCES.

(Detachment from No. 3 Party, Revenue Branch.)

254. This detachment had been employed during the previous year mainly on experimental work in the Raipur District, as detailed in the last Annual Report, paragraphs 142 to 154. This consisted in (1) the instruction of patwaris in surveying; (2) experimental survey on the "field block" system; (3) cadastral survey of a certain area to test the settlement maps thereof. The Chief Commissioner considered that the results of the season's work gave safe grounds for believing that a professional survey on the "field block" system will form a basis upon which trained patwaris can readily effect the interior survey of the fields and that the cost of the same derived from the experience of the work in Raipur, would not exceed ₹60 per square mile. It was decided therefore to give the system an extended trial in the survey of the Sambalpur District, an area stated to be about 1,200 square miles, and that arrangements should be made for the professional skeleton survey of 500 square miles during 1884-85, and for the completion of the remaining

Personnel.

Mr. P. A. G. Cowley, Surveyor, 1st grade, in charge.
" G. C. Swiney, Assistant Surveyor, 3rd grade.
" E. F. Berkeley, " " " "
11 Sub-Surveyors and others.

Temporary Establishment.

50 Field Surveyors and others.

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* Colonel Coddington has reported of his assistants as follows:—

"The whole establishment with one exception worked cheerfully and well and deserve my thanks and acknowledgments. Mr. Barker especially distinguished himself by his excellent and large out-turn of field work."

CENTRAL PROVINCES SURVEY

INDEX TO THE CADASTRAL SURVEY OF DISTRICT SAMBALPUR.

DETACHT. No. 3 REV. PARTY.

Published under the direction of Colonel G. C. De Prée, R.E., Surveyor General of India.

Survey of India Office, Calcutta, November 1885.

Photozincographed at the Survey of India Office, Calcutta.

700 square miles during the following year; the filling in of the fields to be carried out independently of the survey party by patwaris, the instruction of whom will continue to be one of the duties of the survey party, to be carried out in the course of its block survey operations. It is stated that the decision to adopt the above system for the Central Provinces had been influenced mainly by financial necessities, as it was considered that the cost of a regular cadastral survey would be out of proportion to the increase of revenue to be gained: whether the experiment of employing professional agency for the skeleton map and patwaris for the field survey will be an economical one is still undetermined; but in Sambalpur, it is considered by the Local Government, the experiment will be made under very favourable conditions, for the following reasons. The difficulty of working a survey by means of patwaris arises chiefly from the number of old patwaris who are unable to learn the work; in Sambalpur there will not be this difficulty, as hitherto there have been no patwaris in the district; they will all be new men and only those admitted who are qualified or can qualify in surveying.

255. Arrangements were therefore made to carry out this undertaking. The detachment under Mr. Cowley which had gained experience of the system during the past field season was selected and its establishment augmented to enable it to execute the amount of work required. The party left its recess quarters at Nágpur on 1st November 1884. Field operations were commenced on 18th idem and continued till 22nd April 1885, the party returning to Nágpur on 11th May 1885.

256. The *khalsa* portion of the Sambalpur District in which the survey was required is described as a horse-shoe-shaped basin surrounded by low hills. The work was started in the Bargarh tahsil, an undulating tract of low-lying country, which is mostly covered with jungle, intersected by innumerable streams, and interspersed with small hills varying in height from 400 to 1,200 feet.

257. The out-turn of "field block" survey completed on the 16 inch scale amounted to 499 square miles, comprising 253 villages, the average sizes of the blocks being 95 acres. In addition, preparatory traverse work has been extended over 104 square miles in advance, embracing 52 villages. The procedure adopted was the same as in the previous seasons, which was described in paragraph 147 of the last Annual Report. The survey of the field blocks has been carefully tested by 440 linear miles of check lines measured by the assistants and native inspectors, and the work is reported to have proved good on the whole. The measured traverses have been connected with all the stations of the Great Trigonometrical Survey which fell within the area under survey and the comparison of the direct distances shows that there was an average error of 1·9 feet per mile in the chaining, a very satisfactory result considering the rough ground over which the measurements had to be carried. Azimuth observations were taken at suitable intervals to check the angular work of the traverses.

258. The demarcation was found to be excellent, the boundaries being marked with stone-pillars, while the trijunction points of villages had Y shaped earthen mounds built over them: the latter were found however to be unsuitable to set up a theodolite on, and as it was important for the sake of economy to utilize the permanent marks on the boundaries for the theodolite stations whereby the expense of embedding new marks thereat might be avoided, the trijunction marks were altered: circular platforms, six feet in diameter and one foot high, with a stone embedded in the centre, were erected at these points and these as well as the pillars on the boundaries were adopted for theodolite stations. Ninety per cent. of the stations of observation have been fixed on the existing marks, and when so used the stones have been marked with a cross cut into them at the top. This has proved a great saving in expense, as carriage and labour are both scarce in Sambalpur.

259. Owing to the extreme unhealthiness of the district, the field season proved to be a very anxious and trying one. The whole establishment, with the exception of two of the Europeans, suffered considerably from fever. At one time 50 per cent. of the boundary surveyors and 25 per cent. of the *amins* were laid up and many of them were so enfeebled thereby that after convales-

cence they were not fit for much work. Only two deaths took place in the camp, but this small number of casualties Mr. Cowley attributes to his having allowed the invalids to resign. New men had to be trained for the theodolite work and other amins obtained from Cuttack and the North-Western Provinces to take the place of those who were sick and of those who had resigned. One of the assistant surveyors was incapacitated off and on throughout the season and was forced to take leave. Under these circumstances, the completion of the full out-turn that was estimated is very creditable.

260. The cost-rates of the season's operation are—for the traverse work R26-13-4 per square mile and for the survey of the boundaries of the field blocks R31-7-3 per square mile, making a total of R58-4-7 for the combined operations, which is under the rate estimated.

261. The area of country which was required to be surveyed was stated by the Local Government to be 1,200 square miles and the Survey Department was asked to arrange for the completion of that area in two seasons; it is found now that the area required is 2,300 square miles or nearly double the estimated amount. The original programme therefore cannot be carried out; the area remaining for survey is approximately 1,750 square miles which will employ the detachment at its present strength till about the end of January 1888. The country is very difficult for survey, being mostly covered with dense jungle, and as it is very unhealthy, a considerable margin must be allowed for sickness.

262. The instruction of patwaris in surveying has continued to be one of the duties of this detachment. A training school was opened on 1st December by Mr. Cowley who devoted 2 to 3 hours a day to the work of teaching. In all, 6 inspectors and 133 patwaris were passed, and with 50 of these trained men the settlement officer commenced the interior survey of the fields in February, but with what result is not known to the Survey Department.

263. It has lately been decided to abandon the survey of the details, *i.e.*, of the boundaries of the fields contiguous to the lines forming the blocks and to limit the professional operations to simple traversing. This system during the past season has been put to a test in the area which had been prepared in 1883-84 in the Raipur district, by the survey of the interior fields by patwari agency, and the result has been that the details of the boundaries were found to be "not only not worth their cost, but also positively useless." It is stated that it was found impossible to accept these *survey* details in contradistinction to *traverse* details without first re-chaining the lines or virtually re-surveying them. It was found in some cases that the surveyed boundaries were inaccurate, though it is admitted that these cases were few; field boundaries had also frequently changed or disappeared since they were mapped in the block survey. The latter is really the true reason of the failure and one which might have been expected from a system in which two sets of surveyors have to work over the same ground with a considerable interval of time between. This might have been obviated if the boundaries surveyed by the professional surveyors had been made permanent and unalterable, but it was found impossible by the Revenue Department to have this done, without delaying the survey operations greatly, as the block limits had not been selected previous to the advent of the survey party, and it could then only have been effected by a great waste of time and money in the survey operations. The Survey Department therefore determined the block lines and mapped the boundaries of the fields adjoining them in their natural condition. On finding the unsatisfactory result of the "field-block" system, a trial was made in some villages for which skeleton maps, showing the positions of the traversed points only, had been prepared. The field plotting by the patwaris was subjected to a rigorous test by the Chief Commissioner himself, and it is reported that it proved to be as accurate as that in villages for which surveyed block maps had been prepared (the degree of accuracy is not stated) and had been effected with just as much ease and rapidity. On these grounds the Government of India has sanctioned the proposal of the Provincial Government to abandon the system of block and boundary survey and to substitute the traverse system which provides maps showing the positions of traverse stations only, and this work is now being carried out in the districts under survey. The disadvantages of both these systems from a

professional point of view were fully dilated on in paragraphs 148 to 150 of last year's General Report.*

264. In connection with the patwari survey of the Chhattísgarh Division the Chief Commissioner applied for the deputation of an additional small party to Raipur for survey instruction purposes only. Mr. A. D. Smart, an officer of long experience, was selected for the purpose.

Personnel.
Mr. A. D. Smart, Surveyor, 2nd grade, in charge.

Temporary Establishment.
9 Inspectors, &c.

Instruction work was commenced on 13th November 1884, and was continued throughout the year on the same method as that adopted by Mr. Cowley during the previous season, which the local authorities considered to have proved most successful. The number of pupils that passed through the school during the year aggregates 395: of these three were Assistant Commissioners, four were District Revenue Inspectors, 69 were Revenue Inspectors, and 319 were patwaris; the average cost of instruction of each student amounts to R32-11-8. Mr. Smart reports that the filling in of the fields in the skelcton maps in Raipur was done by patwaris who had passed through his class. The Chief Commissioner, he adds, inspected his office and expressed himself perfectly satisfied with the system and the men who had been passed through the school, having had personal opportunities of judging of the work they had turned out.

GEOGRAPHICAL AND MISCELLANEOUS.

DARJEELING, NEPAL BOUNDARY, SIMLA HILL STATES, &c.

265. The designation of the Darjeeling party has during the year been altered to the Himalaya party, as the *locale* of its future operations was no longer to be confined to the vicinity of Darjeeling. The charge of the party continued in the hands of Colonel Tanner, and the various works performed are as follows:—

(1) The Daling Hills survey.
(2) The Nepál-Bengal boundary.
(3) Bringing up the arrears of mapping and computations connected with the Nepál Boundary survey, the Sikhim triangulation, and the Darjeeling Revisionary survey.

Personnel.
Colonel H. C. B. Tanner, S.C., Deputy Superintendent, 2nd grade, in charge.
Mr. E. C. Ryall, Assistant Superintendent, 1st grade.
Mr. J. Peyton, Surveyor, 1st grade. (Transferred to South Marátha Party from 1st August 1885.)
Mr. W. J. O'Sullivan, Surveyor, 3rd grade. (Transferred to Basti Party from 1st August 1885.)
Mr. W. Robert, Assistant Surveyor, 1st grade.
„ W. C. G. Barckley, do., 1st do.
„ R. W. Senior, Assistant do., 2nd do.
Sub-Surveyor and Explorer R— N—
Sub-Surveyor Sahai Din and others.

(4) The Simla Hill States triangulation.
(5) The Geography of the Himalayas.

266. The 28 subdivisions or blocks into which the land set apart in the Daling hills for tea cultivation is divided, were finally demarcated with permanent pillars, and maps in rough were made over to the Deputy Commissioner, Darjeeling, during the field season for immediate use. The work proved more expensive and troublesome than had been anticipated, and the operations extended over a longer period than was allowed for in making the estimate. A very great deal of time was lost by bad weather. Surveying high mountains on ordinary scales has been found to be costly and slow, and on the large scale of 8 inches to the mile, the difficulties in the way of securing reliable maps are very greatly increased. When the mapping is completed, the results of this survey will be exhibited in seven skeleton and as many hill-shaded sheets; the former, it is considered, will be of special use to the land-holders and other local non-officials; while the latter will be a complete topographical map of the country surveyed. The demarcation entailed the erection of 82 masonry pillars and the cutting of 116 miles of lines through a great deal of primeval forest.

* Mr. Cowley reports favourably of the work of Mr. Swiney who is stated to be a hard-working and painstaking officer and deserving of advancement. Mr. Berkeley was incapacitated from fever off and on during the field season Sub-Surveyors Hidayat Ulla and Alah Dad Khan have done good work.

267. On the Nepál boundary, iron posts and wooden pillars have been erected and a ditch dug along those portions of the new boundary which were surveyed in the preceding year; and a topographical survey on the 1 inch scale was executed along the Gunduk river from Tribeni Ghát down to pillar No. 1 of the North-West Provinces and Nepál boundary: the latter shows that very large changes in the course of the Gunduk have taken place since the time of the last survey, by Wyatt, in 1848-49.

268. Eastwards, the Mechi river having in many places deviated from its course where it formed the boundary between Nepál and Darjeeling, it was found necessary to make a re-survey of the river with a view to a re-arrangement of the boundary: this has been done, and preliminary copies of the maps are now in the hands of the officials who are to lay down on them a new and permanent boundary which shall not be subject to the changes which so rapidly take place in the course of the river.

269. It is to be regretted that already most of the iron posts which were set up last year on the Kamla have been undermined by the floods of the rainy season, and, in demarcating the new boundary along the Mechi, it is to be hoped that care will be taken to erect the iron posts at a considerable distance from the banks so as to render the sites safe against fluvial action. It seems necessary to point out in this place that the ditch which has been excavated at so much expense, is not likely to last unless the Collectors of each district concerned receive early instructions to maintain it in proper order. On the completion of the new demarcations now about to be undertaken on the Mechi and with the exception of a few hundred yards of ditch to be dug near pillar No. 52 (No. 11 of the old series), the demarcation of the Nepál boundary will have been laid down by this department from Independent Sikhim to the Gunduk. The out-turn of this survey was 35 square miles on the 4 inch scale and 65 square miles on the 1 inch scale.

270. On the arrears of mapping and computations, two assistants were employed during the whole of the field season, and a considerable accumulation was thereby cleared off.

271. In the Simla Hill States the triangulation of 550 square miles has been executed in the country between Kalka and Simla extending to the westward of Subáthu and Dagshai, with a view to furnishing a sufficiency of points for the future prosecution of a topographical survey on 4 inches to the mile or even a larger scale.

272. In order to extend our knowledge of the geography of the Himalayas, every opportunity has been taken for fixing additional points. Thus, trigonometrical operations have been carried on in the following localities:—(*a*) on the Gunduk river from bases of the Sumesar hills survey; (*b*) from stations of the North-East Longitudinal Series in the plains facing Eastern and Central Nepál; (*c*) in the *tarái* along the Mechi river and in the Daling hills, from bases derived from the Darjeeling survey; (*d*) from the stations facing Western Bhután, based on the data of the Assam Longitudinal Series; and (*e*) from the stations in Eastern Kumaun facing Western Nepál and Tibet. The observations and computations connected with patches of survey so isolated and fragmentary as those situated in the localities mentioned, are necessarily slower and more laborious than an equal amount of continuous work, and in consequence the entire out-turn is not so large as it might have been under more favourable circumstances.

273. From the combination of the observations included under (*a*) and (*b*) with the work of the previous season, we have now materials for a map of the whole Máhábárát range from Tribeni to Darjeeling, and of all the chief ridges north of the Máhábárát which are visible from the plains, besides the positions of a number of isolated points.

274. The observations included under heads (*c*) and (*d*) have furnished data for the rectification of a considerable amount of the geography of Western Bhután. The distant snows in the vicinity of the Lama's holy mountain of Ku Lha Kangri (*vide* Annual Report for 1883-84, p. xlvi) were only faintly visible, nor could any addition be made to the number of snow peaks already fixed, but several peaks were secured on the Sub-Himalayas which will prove of considerable service as a basis for any future exploration of Bhután. From the new information now obtained, and the geography of South-Eastern Tibet

by the Lama (published last year), it is evident that, except the route survey of Captain Pemberton in 1838, the whole of the geography of Central and Eastern Bhután, as shown on the published maps, is quite theoretical. The Lama's explorations in South-Eastern Tibet have brought to light the large Lhobra river which he traced down to a day's march of the Bhután frontier, but what becomes of this river or which of the branches of the Manás receives its waters, remains to be determined.

275. The operations included under head (*e*) were conducted by Colonel Tanner in person, assisted by R—N—. The existing maps shew no surveyed topography to the east of Kumaun, and the trigonometrical observations (chiefly by Colonel Tanner) and topographical sketching (chiefly by R—N—) executed during the season under report, have partly filled up the blank, but further observations from towards the east of Pilibhít are necessary for strengthening the positions of the peaks fixed in Western Nepál. Colonel Tanner and R—N— crossed the Lipu Lek pass at the north-eastern corner of Kumaun, and reached a spot about a mile-and-a-half from Takla Khár or Purang Jong in Tibet where they were stopped by the Jong Pen or Governor of that place and respectfully ordered back. Some work was done round Takla Khár and the existing map verified. Three of the higher peaks of a new group of snowy mountains called Yángri Yánksi were also fixed and named: these mountains are situated between Nepál and Tibet, and it is thought that they form a part of the district of Humla which is inhabited by a tribe called Katbir who profess Buddhism and are partly subject to Nepál. Strachey's map of the country round Takla Khár was found to require but little correction, and the route of the explorer A—K in 1869 was also found to be remarkably accurate. Colonel Tanner bears testimony to the excellence of the topography executed nearly 10 years ago by Mr. J. Peyton in Eastern Kumaun, which "delineates one of the wildest and most difficult parts of the Himalayas with a fidelity of which any surveyor might be proud."

276. Our knowledge of the hitherto sealed region north of Kinchinjinga has been considerably extended by the explorations of R—N— during the year under report. After suffering great hardships, and losing two men from excessive cold and fatigue, he completed the very arduous undertaking of a circuit round Kinchinjinga, and we now have not only a sketch of the whole of that great mountain and the spurs and valleys that emanate from it, but also a delineation *for the first time* of the boundary between North-Eastern Nepál and Tibet. R—N—'s sketch is a continuation (north-westwards) of Mr. Robert's work in North Sikhim and (north-eastwards) of Hooker's in Eastern Nepál. The explorer has fixed the noted peak of Nuijin Sángra between Kinchinjinga and Shigátze, and verified the position of Khámba Jong as determined the year previously by his cousin the Lama: and to the north-east, far way on the bank of the Brahmaputra, he saw the great snowy mountains, of which the two most prominent were observed by Hooker from Bamtso (Bhomtso) but of which none have as yet been fixed by explorers. R—N—also completed the sketch of the Zemu river, and rectified some names which had been erroneously accepted before: he crossed from the drainage of the Tambur river into that of the Teesta by the Jongsong La pass, which the Lama, who had previously ascended it, stated to be the highest pass he had ever encountered. The explorer met with many glaciers in the northern valleys, and this contradicts the statement as to the non-existence of these glaciers made in Colonel Tanner's report of last year which was evidently based on erroneous information.

277. Extracts from Colonel Tanner's Narrative Report and an original report by R—N— will be found at page xlviii of the appendix.

278. It is impossible to deduce any statement of cost-rates of the different operations owing to the party having chiefly been employed in completing unfinished portions of the work of former years.

279. Mr. E. C. Ryall has now been placed in charge of the Coast Survey Party and Lieutenant Pollen, R.E., appointed to this party in his stead.*

* Colonel Tanner reports favourably of the work done by all his assistants, making special mention of Messrs. Robert and Barckley and of R—N—.

TIDAL AND LEVELLING OPERATIONS.

280. The conduct of these operations remained under the superintendence of Major Baird until 4th July 1885, when, having been appointed to officiate as Master of the Calcutta Mint, he was succeeded by Major Hill, (from the South Marátha Party), who retained the charge until Major Baird's return on 19th October 1885.

Personnel.

Major A. W. Baird, R.E., F.R.S., Deputy Superintendent, 3rd grade, in charge till 4th July 1885.
Major J. Hill, R.E., Deputy Superintendent, 3rd grade, in charge from 4th July 1885.
Mr. H. E. T. Keelan, Surveyor, 1st grade, transferred 1st July 1885.
„ G. Belcham, Surveyor, 3rd grade.
„ T. H. Rendell, „ 4th „ transferred 17th August 1885.
„ E. J. Connor, „ „ „
„ H. Corkery, B.A., LL.B., Assistant Surveyor, 2nd grade, joined 29th July 1885.
Sub-Surveyor Narsing Das.
„ Dhondu Venayek, and 16 Recorders and Computers.

TIDAL OPERATIONS.

281. The recording of the tidal curves by the self-registering tide gauges, their reduction, and the publication of tables of predicted tides, have continued during the past year as usual. Of the 19 tidal observatories reported last year as in working order, two (Beypore and Vizagapatam) have during the year under review been closed after a full course of work extending over five years, and their equipment has been removed for the erection of two new observatories at Cochin and Cocanada. One observatory, False Point, was swept away by the cyclone which committed such devastation on the coast of Orissa on the 22nd September last, the observatory clerk being among the many who lost their lives in that disaster. As nearly four-and-a-half years' continuous observations had been recorded at this observatory, it will not be necessary to erect another at this ill-fated spot.

282. The usual account of the working of each observatory will be found in the Appendix. At Negapatam about half a year's work was wasted through the silting up of sand in the vicinity of the observatory and the failure of the clerk to report the matter or take steps to remedy the hindered flow of water into and out of the float box, otherwise the observatories have worked satisfactorily with only the usual trivial interruptions.

283. The whole of the observatories have been visited and inspected once or oftener either by Major Baird or an Assistant during the past year, and with the exception of those in the Aden observatory, where it was not convenient to send the native mechanic at the time the observatory was inspected, every instrument has been thoroughly overhauled and cleaned.

284. With regard to the reductions of the observations, very good progress has been made. The observations at the various stations have been analysed in accordance with the method recommended by Professor Darwin and explained in a former report, and the reductions of one year's observations at fifteen ports have been completed since the date of the last report; in addition, the whole of the observations of previous years at the various tidal stations have been analysed as regards the four new series, so as to obtain the amplitudes and epochs of the four new tidal co-efficients which Professor Darwin considered necessary to be included in the reduction; this represents a vast amount of work, but more specific information on this subject will be found in the Appendix.

285. The Tide Tables for 1886 will contain the predictions of the high water and low water at 23 ports, which is an increase of three over what was given for 1885; the new ports included being Galle and Colombo in Ceylon, and Marmagao (near Goa), which is the harbour under construction at the terminus of the Western India Portuguese Railway.

The predictions for 1884 may be summarised as follows :—

Percentage of predictions within 15 minutes of actuals.

	High water.	Low water.
Open coast stations	78 per cent.	76 per cent.
Riverain „	62 „	67 „

Percentage of predictions within 8 inches in height of actuals,

	High water.	Low water.
Open coast stations	98 per cent.	97 per cent.
Riverain „	76 „	66 „

286. Every one of these percentages except the time prediction of high water at Riverain stations is higher than the corresponding percentage for the previous year. The detailed lists of comparisons will be found in the Appendix.

287. The stations at which observations were in regular progress at the close of the year under report are—

Aden,	Galle,	Kidderpore,
Kurrachee,	Negapatam,	Rangoon,
Bombay,	Madras,	Elephant Point,
Marmagao,	Dublat (Saugor Island),	Amherst,
Colombo,	Diamond Harbour,	Moulmein,
		Port Blair,

to which have now to be added three stations, Cochin, Cocanada, and Bhavnagar, at which the observations are about to be commenced. The latter observatory has been erected at the cost of the Bhávnagar Darbar. At the end of April 1886, it is intended to dismantle the Moulmein observatory and remove the equipment to Chittagong for the starting of an observatory there in compliance with a requisition from the Bengal Government.

LEVELLING OPERATIONS.

288. During the past season there was a very satisfactory out-turn amounting to 533 miles of double levelling, the largest on record, it is believed, made by one party in one season. It consists of a double line from Madras along the railway line to Beypore with a branch from Jalárpet junction to the Bangalore Base-Line, and many connections with trigonometrical stations, and of two lines of connection between the Madras and Beypore tidal stations and two pairs of test bench-marks—one pair being about 5½ miles west of Madras and the other about 18 miles east of Beypore. These latter connections have been made with a view to the detection of secular change of level between the land and the sea by periodic repetition of the connections.

289. The revision of the heights of the Khánpisura Series was completed by Mr. Keelan very soon after the commencement of the field season: the Trigonometrical Party was then employed on the Singi Series, and the revision of the heights of that series also was completed before the end of the season.

The total cost of these operations is as under :—

	₹
Tidal	33,400
Spirit-levelling	16,204
Trigonometrical	9,120
TOTAL.	58,724

290. The extracts from Narrative Report will be found at page lix of the Appendix and cost rates at page 62 Part II.*

OPERATIONS IN CONNECTION WITH THE REVENUE SURVEYS.

291. The small party of levellers in British Burma attached to the Henzada District survey, took the field with the cadastral survey party on the 1st December 1884, under the superintendence of Major Hutchinson. It was intended that they should continue the Ngawun valley series, from Ngaputaw, about 20 miles below Bassein where the operations had been closed the previous year, to Pagoda Point at Cape Negrais; the difficulties of the ground, however, precluded the possibility of this being carried out within the sanctioned expenditure. The work was of a very heavy and difficult nature. Instructions were given to the levellers to keep as nearly as possible along the telegraph line,

* Major Baird reports favourably on all his Assistants, special mention being made of Messrs. Belcham and Connor.

taking advantage of the jungle-clearing, wherever it approached sufficiently near the river. The creeks which intersect the country in all directions, however, proved a source of very great trouble. As the progress was very slow, an Assistant Surveyor was sent to inspect the work, and report on the country over which the operations had still to be carried. The result of his enquiries showed that it would be futile to attempt the completion of the series to Cape Negrais during the present season owing to the rough nature of the ground, the heavy jungle and the numerous water-channels. Orders were therefore issued to discontinue this line at Nagotna and to close it on the nearest trigonometrical stations, and in place thereof to run a series from Bassein to Pantanaw, with the object of securing the accuracy of the work as far as Bassein. The value of the secondary points closed on, *viz.*, Awabeit, Bianji, and Ngaputaw Great Trigonometrical stations showed, as in former years, discrepant results, varying from 4 feet to 8 feet error, which is not surprising considering the unreliable nature of these trigonometrical heights. The branch line from Bassein to Pantanaw was duly carried out and connected with the Irrawaddy valley series, with which it closed well, showing that the levelling work as far as Bassein may be relied upon as correct; the Deputy Superintendent thinks that, with the precautions taken, there will be no mistakes in the small extension from Bassein to Nagotna, although there is no satisfactory check of this portion of the work. The line of levels measured is 116 miles in length and double throughout, and the number of bench marks fixed is 123. The field work closed early in May and the party returned to Rangoon and completed the computations and records by the 1st of July. The local Government having intimated that no further levelling operations were required to be undertaken, the party was then broken up.

GEODETIC.

LATITUDE OPERATIONS.

292. Owing to no second officer being available who had been trained to use the Electro-Longitude apparatus, it was decided to temporarily suspend those operations, and to resume the observations for Astronomical Latitudes with the Zenith Sector, in abeyance since 1871-72.

Personnel.

(Astronomical Party No. 1.)
Major W. J. Heaviside, R.E. (in charge), Deputy Superintendent, 2nd grade.
Mr. P. F. Prunty, Assistant Surveyor, 2nd grade.
Baboos Dhondo Balwant Joshi and Tikka Ram.
(Astronomical Party No. 2.)
Baboo Harsahai.

The parties assembled at Sháhjahánpur on the 10th of November under orders to carry a series of latitude observations down the Amúa meridional series. This series runs between the meridians of 80° and 81°, and the latitude stations were to be selected about half a degree apart, the most northern station lying in latitude 28° 22′, sufficiently far, it was thought, from the Himalayas to be beyond the influence of any considerable attraction from that mass of mountains.

293. The Zenith Sectors are numbered 1 and 2, and on the last occasion on which they were used, No. 1 gave what has generally been called in this department a large (N—S) error, or in other words a larger value of latitude by stars north than by stars south of the zenith. No. 2 has in consequence been used this season. Observations have been taken at eight stations, the most northern being in latitude 28° 22′ and the most southern in latitude 24° 37′. Astronomical latitudes have been observed in former years at Amúa in latitude 24° 0′ and at Jubbulpore in latitude 23° 10′, so the astronomical latitudes are now completed for 5 degrees of this Arc, which will eventually be extended to Madras in latitude 13° 4′.

294. During the season 9 stations, some of which were re-built, have been protected and handed over to native officials. On an average 125 observations have been taken at each station, extending over four to six nights, the stars being pretty equally grouped north and south of the zenith; the pillar of the instrument was revolved through 180° at each station on the completion of half the observations, and no observation was deemed complete unless the

star was observed on the same night in the two positions of the vertical axis called "Telescope East" and "Telescope West."

295. Owing to Major Heaviside being ordered to close his recess office somewhat early in order to take a series of observations at Agra in concert with the Officiating Deputy Surveyor General in charge of the Trigonometrical Branch for the purpose of testing the Longitude transit instruments recently repaired by the makers in England, the reduction of the season's observations was not completed and consequently the results will be discussed in the report for next year.

296. Extracts from Major Heaviside's Narrative Report will be found at page xc of the Appendix; and the cost rates at page 62 Part II.*

* Major Heaviside reports that Mr. P. F. Prunty who joined the party on the 10th of November, was generally employed building the stations in advance, which work he performed satisfactorily and with intelligence and Baboos Harsahai and Dhondo Balwant Joshi worked well.

Summary of the Out-turn of field work of the Parties

Scale of Survey.	Name and *locale* of Field operations.	Instruments used.	Area triangulated in square miles.	Number of stations at which observations were taken.	Number of square miles to each point trigonometrically fixed.	Number of square miles to each height.	Triangulation. 2nd class triangulation, in which each angle is usually observed on two zeros. Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	Tertiary triangulation, in which two angles of each triangle are observed. Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.	Number of extra heights determined.	
Trigonometrical	Astronomical Nos. 1 and 2	14″	...	19	...	...	...	...	...	...	...	...	...	...	...	...	1
	Coast (Orissa and Ganjam)	12″	600	47	4	22	21	40	4	0·2	27	97	146	...	...	...	
	Spirit-levelling (Madras Presidency)	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
64″=1 mile	Akyab City	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
16″=1 mile	Ajmere-Merwara Districts	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5
	Akyab	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Bassein and Henzada District	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Benares and Basti	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Dehra-Dún District	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Gorakhpur	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10
	Kámrup	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Mirzapur (Dudhi Pargana)	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Punjab (Karnal Farm)	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Sambalpur	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
12″=1 mile	Cutch (Bhuj City, &c.)	5″, 6″	13·7	20	0·2	0·3	17	24	18·0	0·8	17	49	95	3·2	34	...	15
12″,6″=1 mile	Malwa (Kherwara and Dungarpur)	5″	11	35	0·1	0·1	24	49	39·8	1·0	...	70	83	0·6	109	43	
12″=1 mile	Mysore (Bangalore Cantonment)	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Rajputana (Ajmere City)	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
6″=1 mile	Rajputana (Jeypore and Amber)	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
4″=1 mile	Ajmere and Merwara	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20
	Andaman (Port Blair)	5″	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Basti	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Burma	7″, 6″, 5″	814	33	17	19	28	72	11·6	0·5	28	20	38	0·7	20	281	
	Gorakhpur	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Gujarát	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	25
	Henzada	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Himalaya (Nepál Boundary)	6″	...	1	...	...	...	...	...	...	...	...	...	...	...	...	
	Konkan (Thána)	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2″=1 mile	Akyab	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Burma	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	30
	Cutch	5″, 6″	2,120	104	3·8	...	97	155	9·9	0·4	97	463	789	0·5	405	...	
	Deccan	6″, 7″, 10″, 12″	2,497	184	4	4	119	326	12·0	0·7	119	530	1,062	1·1	753	600	
	Gujarát	7″	2,162	142	3·6	4·5	107	211	10·1	0·4	112	636	1,105	0·7	584	213	
	Henzada	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Konkan (Kolába)	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	35
	Mirzapur	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Punjab	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Shwegyin	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	South Marátha	5″, 6″, 7″, 12″	1,230	78	6·3	4·4	99	116	9·7	0·3	66	125	275	0·6	95	114	
1″ = 1 mile	Himalaya (Nepál Boundary)	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	40
	Ditto E. and W. Nepál	12″	...	26	...	...	28	26	8·0	0·3	14	424	762	0·3	...	...	
	Ditto (Bhutan)	12″	...	...	...	...	...	...	...	...	...	50	...	...	...	...	
	Ditto (Daling Hills)	6″	...	30	...	...	111c	228	19·0	0·6	42	...	...	...	...	...	
	Ditto (Simla Hill States)	12″	550	45	3·1	...	175c	372	7·0	0·3	...	...	...	...	...	...	
	Malwa	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	96	45
	Mysore	8″	900	22	4	5	14	28	4·0	0·4	14	212	354	0·6	178	232	
	Rajputana	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
½″ = 1 mile	Andaman	10″	1,000	9	15·5	45	6	6	7·8	...	6	55	74	2·1	12	3	
	Baluchistan	.....	780	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Cutch	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50
Reconnaissance.																	
1″, ½″, ¼″	Assam and North-East Frontier	6′	3,610	5	73·7	54·7	5	8	16·0	3·0	3	42	48	9·0	31	35	
¼″	Baluchistan	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	52

of the Survey of India Department during the year 1884-85.

	SPIRIT-LEVELLING OPERATIONS.				TRAVERSING.					TOPOGRAPHY.						Remarks.
	Number of miles levelled over.	Number of permanent bench-mark stones embedded.	Number of trigonometrical stations connected with lines of level.	Number of other permanent points fixed as bench-marks.	Number of stations at which theodolite was set up.	Linear miles.	Average angular error per station in seconds.	Average error per 1,000 links in links.	Square miles, main circuit and boundary survey.	Area completed during the season in square miles.	Average number of plane-table fixings per square mile.	Number of linear miles of test line.	Number of villages.	Number of fields.	Average size of fields in acres.	
1	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	532	47	9	393	...	...	...	...	...	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	2·5	...	...	...	...	...	
5	...	...	...	...	13,803	3,229	5	0·8	1,000*a*	...	...	...	453	...	...	*a* Including interior skeleton traverses.
	...	...	...	...	...	...	...	...	624	562	...	996	399	1,191,392	0·13	
	...	...	...	...	...	...	...	...	...	632	...	...	255	501,019	0·33	
	...	...	...	...	27,482	4,686	3	0·3	972	667	...	2,000	2,172	1,102,226	0·39	
	...	...	...	...	...	...	1	0·6	...	120	...	38	99	21,497	1·87	
10	...	...	...	...	...	...	2	0·1	972	747	...	2,020	2,183	899,793	0·53	
	...	...	...	...	10,862	4,530	7	0·2	911	478	...	1,081	400	287,189	1·06	
	...	...	...	...	5,282	881	10	2·0	...	...	...	...	85	...	...	
	...	...	...	...	...	...	...	...	...	4	...	...	...	...	...	
	...	...	...	...	...	...	1	0·3	499*b*	...	...	440*c*	253	...	...	*b* Field block survey, including skeleton traverse.
15	...	...	...	...	282	25·6	10·6	0·9	...	11·8	209	*in situ*	...	...	...	*c* Check survey of Field blocks.
	...	...	...	...	210	40	38·6	2·4	...	{ 4·40 / 6·29 }	...	...	...	...	...	
	64·5	...	...	...	211	24	1·7	1·04	...	33	...	34	...	...	...	
	...	...	...	...	...	...	...	...	...	5·58	161	15	...	...	...	
	...	...	...	...	...	...	...	...	...	77·31	91	16	...	...	...	
20	...	...	...	...	...	...	...	...	145	...	...	...	...	...	...	
	...	...	...	...	791	32	1	4	...	111	119	62	...	...	...	
	...	...	...	...	...	...	...	...	...	70	...	...	44	...	...	
	...	...	...	...	9,993	633	6	5·0	...	314	206	92	...	...	...	
	...	...	...	...	...	...	...	...	...	92	...	...	110	...	...	
25	...	...	...	...	...	...	...	...	...	22	38	9	...	...	...	
	...	...	...	...	...	...	...	...	...	23	...	...	...	...	...	
	...	...	...	...	66	35	4	0·3	...	35	9	...	...	...	...	
	...	...	...	...	490	219	6	0·5	240	463	42	75	...	...	...	
	...	...	...	...	...	...	...	...	...	70	...	...	...	...	...	
30	...	...	...	...	...	...	...	...	...	37	...	...	...	...	...	
	...	...	...	...	761	754	10·1	2·0	...	1,641	13	420	...	...	...	
	...	...	...	...	4,129	1,103	3	0·8	...	1,662	22	104	...	...	...	
	...	...	...	...	2,487	445	16	1·9	...	1,711	31	535	...	...	...	
	...	...	...	...	...	...	...	...	...	245	...	...	...	...	...	
35	...	...	...	...	...	300	12	0·9	...	566	12	13	...	...	...	
	...	...	...	...	...	...	...	...	...	543	42	*in situ*	...	...	...	
	...	...	...	...	...	6,279	6	0·3	...	792*d*	...	939	...	...	...	*d* Area tested only and the maps compiled from the Patwari Survey.
	...	...	...	...	...	958	...	...	...	1,142	...	360	...	...	...	
	...	...	...	...	2,726	695	·5	0·6	758	...	...	...	...	...	...	
40	...	...	...	...	...	..	...	...	...	65	2	...	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*e* Includes stations and intersected points.
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
45	...	...	...	...	...	...	...	...	...	1,157	19	156	...	...	...	
	...	...	...	...	...	...	...	...	...	2,365	12	183	...	...	...	
	...	...	...	...	...	...	...	...	...	1,808	8	34	...	...	...	
	...	...	...	...	...	...	...	...	...	670	2	*in situ*	...	...	...	
	...	...	...	...	...	...	...	...	...	5,397	...	*in situ*	...	...	...	
50	...	...	...	...	...	...	...	...	...	612	0·3	*in situ*	...	...	...	
	...	...	...	...	...	...	...	...	...	3,265	0·04	209	...	...	...	
52	...	...	...	...	...	...	...	...	...	2,320	...	...	...	...	...	

Statement shewing the Cost-rates of Work executed by the several Field Parties of the Survey of India Department during the year 1884-85.

Names and *locale* of Field Parties.	Cost-rate per square mile in rupees.		Cost-rate per square mile for each scale of detail survey, in rupees.								Rate in annas for Traverse and Detail and Preparation of Maps.		Cost-rates.					Total cost of party.	Remarks.
											Scale 16" = 1 mile.		Stone embedding.	Records (Khanapuri.)		Completion of Nagri, &c., records, assessment statistics, &c.			
	Triangulation.	Traversing.	½"	¼"	1"	2"	4"	6"	12"	16"	Per acre.	Per field.	Per square mile.	Per square mile.	Per field.	Per square mile.	Per field.		
											a. p.	*a. p.*	*R*	*R*	*a. p.*	*R*	*a. p.*	*R*	
Topographical Surveys.																			
Andaman	6·4	39·4 (1)	...	9·7	...	...	233·0	...	...	...	...	...	...	...	...	...	...	40,667	
Assam (North-East Frontier explorations)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	74,940 (a)	(a) Including R2,338 pay of Dr. Grant, Indian Medical Department, attached to the Expedition.
Baluchistan	3·7	...	...	6·7	...	...	...	...	...	...	...	...	...	...	...	...	...	57,031	
Burma (unreserved forests)	...	...	...	...	...	61·2	...	...	...	...	...	...	...	...	...	...	...	...	(b) Excluding R6,450 for large scale survey of Ajmere, paid for by Municipality.
Cutch	7·4	17·5	...	3·2	...	14·2	...	...	476·5	...	...	...	...	...	...	...	...	54,230	(c) Excludes R3,353, charge for October 1884, expended in bringing up cadastral records of previous seasons, and includes R2,852 expended in October 1885 and travelling charges from Burma to Calcutta.
Deccan	6·1	6·2	...	...	...	17·4	...	...	...	...	...	...	...	...	...	...	...	53,953	
Gujarát	10·2	6·6 (1)	...	...	...	35·6	...	...	...	...	...	...	...	...	...	...	...	85,875	
Himalaya	15·9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	81,250	(d) Excluding demarcation charges, R759, and purchase of 3 elephants, R3,394.
Malwa	...	...]	...	...	39·7	...	...	209·8 (2)	342·8 (2)	...	...	...	...	...	...	...	...	48,707	(e) Including R826 expended on 4-inch mapping of Rawalpindi District, R4,472 on traverse data of Hissar District for Settlement Department.
Mirzapur	...	41·8(4)	...	...	...	70·9 (2)	...	...	...	...	...	...	...	...	...	...	...	56,919	
Mysore	9·6	...	...	...	19·6	...	...	...	612·4	...	...	...	...	...	...	...	...	75,302	(f) Exclusive of R1,635 expended on the Survey School.
Rajputana	...	...	...	...	17·5	...	...	295·6 (3)	...	...	...	...	...	...	...	...	...	51,081 (b)	
Konkan (Kolába and South Maratha)	13·5		...	...	...	29·3	...	...	...	...	...	...	...	...	...	...	...	51,909	(g) Exclusive of R6,400 expended on the Akyab Town survey and of R2,552 furlough allowance of one Assistant and inclusive of R9,748 on revision of previous season's maps.
Shweygyin	...	53·7 (5)	...	...	...	42·2	...	...	...	...	...	...	0·6	...	...	...	...	1,10,395 (c)	
Forest Surveys.																			
Burma	12·2	87·8	...	...	...	...	159·7	...	...	...	...	...	...	...	...	...	...	1,06,736 (d)	(h) Inclusive of R7,676 expended on revision of boundaries and maps of previous seasons in Ballia and Benares and 4,472 on 2-inch and 4-inch mapping of the same districts.
Konkan (Thána)	...	...	...	...	...	...	39·2	...	...	...	...	...	...	...	...	...	...	...	(i) Inclusive of R2,552 expended on demarcation of Rampur State boundary, and R1,279 on 2-inch mapping.
Traverse Surveys.																			
Ajmere	...	54·1 (6) / 23·3 (7)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	57,330	(k) Inclusive of R11,782 expended on revision of previous season's maps.
Punjab	...	6·5 (8)	...	...	...	14·2	...	...	...	177·0	...	...	0·9	...	...	...	...	67,838 (e)	(l) Inclusive of R1,142 expended on revision of previous season's maps and R1,525 on 2 inch mapping.
Sambalpur	...	26·8 / 58·3 (9)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	31,968 (f)	(1) Per linear mile.
Cadastral Surveys.																			(2) Includes triangulation and traversing.
Akyab	...	78·5	...	...	...	26·4	...	...	...	205·6	7 1	2 2	10·7	...	...	...	...	1,83,485 (g)	(3) Includes triangulation.
Basti	...	21·4	...	...	...	...	23·6	...	...	67·9	2 8	1 0	6·2	61·7	0 7	53·5	0 6	1,62,193 (h)	(4) 16 inch scale per linear mile.
Dehra-Dún	...	...	...	...	...	...	...	...	...	165·6(10)	4 2(11)	14 9	...	...	...	...	...	19,868	(5) This includes the survey of Kwin boundaries.
Gorakhpur	...	16·8	...	...	...	...	29·5	...	...	66·3	2 1	1 1	9·8	34·3	0 5	43·8	0 8	1,45,303 (i)	(6) Boundary, and interior skeleton traverse survey on 16 inch scale.
Henzada	...	...	...	...	...	6·1	21·0	...	...	208·2	5 2(11)	4 2	...	...	...	...	...	1,46,542(k)	(7) Boundary, roads and fire-paths skeleton of Forests on 4 inch scale.
Kamrup	...	31·8	...	...	...	...	...	...	...	92·8	3 1	3 2	...	42·8	1 2	48·3	1 3	1,19,481 (j)	(8) Limited traversing of 2 to 3 points per village.
Trigonometrical Surveys.																			(9) Cost-rate of field block survey, including cost of skeleton traverses on 16 inch scale.
Coast (Ganjam, Vizagapatam and Godávari)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	25,147	(10) Includes writing of *khasras*, separate cost of which is not available.
Astronomical Nos. 1 and 2 (North-Western Provinces and Central India Agency).	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	29,233	(11) Exclusive of traversing.
Tidal and Levelling (India)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	58,724	

Abstract of Area and Cost of the Revenue Branch Parties according to Jurisdictions.

Provinces.	Scale of Survey.	Area in square miles.	Cost.	Remarks.
			R	
North-West Provinces	16 inches = 1 mile	2,531	3,27,364	
	4 do. = 1 do.	162		
Punjab	16 do. = 1 do.	4	67,838	(a) Area tested only and maps compiled from the Patwari Survey.
	2 do. = 1 do.	792(a)		
Assam	16 do. = 1 do.	478	4,19,481	
British Burma	16 do. = 1 do.	1,194	4,40,422	
	4 do. = 1 do.	23		
	2 do. = 1 do.	1,457		
Bombay	4 do. = 1 do.	483	1,05,861	
	2 do. = 1 do.	2,223		
Central Provinces	16 do. = 1 do.	499	31,868	Skeleton field-blocks.
Rajputana	16 do. = 2 do.	3,000(b)	57,330	(b) Boundary and interior skeleton survey.
	4 do. = 1 do.	145(c)		(c) Boundary, roads, and fire-paths skeleton survey of Forests.
	TOTAL	9,999	17,50,164	

Tabulated Statement of the principal Records prepared in the several Recess Offices of the Field Parties of the Revenue Branch for the year ending 30th September 1885.

Province and District.	Survey Party.	Mapping.						Traverses.		Field Books.		Area Books.		For Settlement Department.		Remarks.
		Original field sections.	Cadastral 16-inch sheets.	Sheets 4 inch = 1 mile 7½′ × 3½′.	Quarter sheets 2 inch = 1 mile 15′ × 7½′.	Index maps.	Triangulation charts.	Main circuit with azimuth computations.	Village or sub-circuit.	Main circuit.	Village or Sub-circuit.	Villages.	Fields.	Sheets or traces.	Village areas or khasras.	
							Cadastral Surveys.									
North-Western Provinces.																
Dehra-Dun	Detacht.	.....	193	.....	.....	.....	.....	1	.....	...	.....	180	21,497	375	99	
Basti	No. IV	.....	1,402(a)	.....	.....	1	.....	1 1 Az.	1	1	10	2,172	1,102,227	2,900	2,965	(a) Inclusive of 3 32″ sheets and 8 80″ sheets.
Gorakhpur	No. V	1,735 on 16″	1,745	.....	.....	.....	.....	1 Az. 2	1 Az. 9	1	10	2,581	1,019,469	2,581 Urdu 2,581 Hindi	2,581	
Central Provinces.																
Sambalpur	Detacht.	.....	578	.....	.....	1	.....	1	3	1	9	253	3,349(b)	3 Index Maps 65 Field Blocks	.....	(b) Field blocks.
Assam.																
Kamrup	No. VI	.....	654	.....	31	1	.....	1 1 Az.	3	1	8	403	287,169	400	400 Villages. 334 Nisf-khiraj. 73 Lakhiraj 3 W. L. Grants.	Also 2 sheets computation of Rectangular co-ordinates of G. T. stations and corners of sheets.
British Burma.																
Akyab	No. VII	3 Kaladan river on 2″ 1 Mayu hills on 2″.	41 on 64″ 905	.....	.....	1	.....	2	4	2	8	290	1,191,392	188	.....	
Henzada	No. VIII	12	625	.....	28	.....	.....	1 1 Az.	7	1	12	192	402,944	625	192	28
Bassein	Ditto	12 on 2″ & 4″	109	.....		.....	.....	1 Az.	2	1	3	63	98,075	109	63	
Rajputana.																
Ajmere-Merwara	No. III	.....	1,500	20	20	2	.....	2	4	2	14	...	.....	1,322	464 (c)	(c) Copies of traverse data.
							Topographical Surveys.									
Punjab.																
Ferozepore	No. I	71 on 2″(d)	.....	.....	.....	.....	.....	1	1	1	3	...	.....	71	241 (d)	(d) Details obtained and reduced by pentagraph from settlement maps. (e) Copies of traverse data.
Jullundur, Kapurthala		29 on 2″(d) 5 on 16″	.....	.....	6	.....	.....	1	1	1	2	...	.....	30	1,423 (e)	
Karnal (Government Cattle Farm)		4	.....	.....	.....	.....	.....	1	.....	1	.....	...	.....	.....	.....	
Ludhiana		28 on 2″(d)	.....	.....	.....	.....	.....	1	1	1	2	...	.....	26	899	
Umballa		47 on 2″(d)	.....	.....	.....	.....	.....	1	1	1	5	...	.....	47	1,522	
British Burma.																
Shwegyin	No. II	96 on 2″	.....	.....	14	1	.....	6	10	7	17	...	.....	14	...	
Bombay.																
Thana	No. X	38 on 4′	.....	18	4	2	2	.....	1	...	1	...	.....	.....	.....	1 Vol. computation of co-ordinates of corners of sheets, Thana district.
Kolaba	Ditto	.....	.....	.....	10	.....	.....	.....	1	...	1	...	.....	.....	.....	
Kolaba, Ratnagiri, Satara, Kolhapur, Southern Maratha Agency	No. XI	20 on 2″	.....	.....	17	1 Trav. (Sheets 46, 51, 71 & 72)	2 (Sheets 46, 51, 71, 72, & 67 63, 69, 70).	.....	1 (Sheets 71 & 72).	...	2 (Sheets 71 & 72).	...	.....	.....	.....	
Oudh and North-Western Provinces.																
Fyzabad	No. IV	7 on 4″	.....	8	.....	.....	.....	.....	1 1 Az.	...	1 Az.	...	.....	.....	.....	
Azamgarh	No. V	10 on 4″	.....	13	.....	.....	.....	.....	.....	...	.....	...	.....	.....	.....	

PART III.

THE OPERATIONS AT THE SEVERAL HEAD-QUARTERS OFFICES.

1. These offices comprise—

(1) The Survey of India Offices at the Presidency.
(2) The Trigonometrical Branch Offices at Dehra Dun.

There has been no change in the general arrangement of these offices during the year under report: in all the work has been continually increasing.

Personnel.

Lieutenant-Colonel H. R. Thuillier, R.E., Deputy Surveyor General, in charge Revenue Surveys.
Major C. Strahan, R.E., Officiating Deputy Superintendent, 1st grade, Assistant Surveyor General.
Lieutenant-Colonel W. H. Wilkins, S.C., Officiating Deputy Superintendent, 2nd grade.
Major M. W. Rogers, R.E., Deputy Superintendent, 3rd grade, Assistant Surveyor General.
Mr. G. H. Cooke, Officiating Deputy Superintendent, 4th grade, up to 30th April 1885.
Lieutenant F. B. Longe, R.E., Officiating Deputy Superintendent, 4th grade, from 17th January 1885 to 3rd March 1885.
Lieutenant H. M. Jackson, R.E., Assistant Superintendent, 1st grade, from 6th May 1885 to 7th September 1885.
Lieutenant G. B. Hodgson, S.C., Assistant Superintendent, Officiating 1st grade, from 5th September 1885.
Mr. J. Eccles, M.A., Assistant Superintendent, 2nd grade, from 30th May 1885 to 25th July 1885.

SURVEY OF INDIA OFFICES.

Mr. T. W. Babonau, Registrar.

SURVEYOR GENERAL'S OFFICE.

Correspondence Section.

Mr. M. Francis, Head Clerk.
Babu Banee Madhub Banerjee.
„ Chuni Lall Dey, and one other.

Account Section.

Mr. E. D. Algar, Head Accountant.
Babu Rama Churn Chuckerbutty.
„ Raj Krishna Mookerjee.
„ Okhoy Coomar Dutt, and five others.

General Section.

Mr. T. E. Ware, Examiner, up to 17th July 1885.
„ J. A. Vallis, Officiating Examiner, from 18th July 1885.
„ H. R. D'Mello, from 21st August 1885.
Babu Bheecum Singh.
„ Gopal Chunder Doss, and six others.

REVENUE SURVEY BRANCH OFFICE.

Mr. A. C. Cunningham, Head Clerk.
Babu Kali Podo Banerjee.
„ Ram Kristo Chunder.
„ Raj Kumar Dutt, and one other.

TOPOGRAPHICAL SURVEY BRANCH OFFICE.

Mr. F. A. D'Rozario, Head Clerk, up to 17th July 1885.
„ T. E. Ware, Officiating Head Clerk, from 18th July 1885.
Babu Doorga Narain Ghose, and one other.

MAP RECORD AND ISSUE OFFICE.

Mr. A. E. Byrn, Head Assistant.
„ P. C. H. Smart, Map Curator, up to 31st August 1885.
„ H. R. Vallis, Map Salesman and Officiating Map Curator, from 1st September 1885.

DRAWING OFFICE.

Mr. G. A. McGill, Chief Draftsman.
„ S. M. Smylie, Head „
Mr. R. C. D. Ewing, Draftsman, on furlough from 17th September 1885.
„ W. Green, Draftsman.
„ J. R. Adels, „
„ A. R. Musgrove, „
„ R. Sinclair, „
„ W. P. Smith, „ died 7th May 1885.
„ A. S. Bateman, „
„ G. Gill, „ and two others.

Native Draftsmen.

Munshi Sunaullah.
„ Nabi Buksh.
Babu Harihur Sen.
„ Mohesh Chunder Shaw.
Munshi Mutiullah.
Babu Purna Chandra Sen.
„ Radhica Prosad Doss, and 36 others.

Surveyors and Assistant Surveyors on duty.

Mr. W. Todd, Surveyor, 2nd grade.
„ J. A. May, Surveyor, up to 23rd October 1884.
„ F. Adams, Surveyor.
„ A. G. Wyatt ditto, from 7th November 1884.
„ M. F. Ogle, ditto, 3rd grade from 30th July 1885.
„ P. J. W. Doran, Assistant Surveyor, 1st grade, up to 31st December 1884.
„ S. O. Madras, Assistant Surveyor, 1st grade.
„ E. J. Martin, ditto, 1st grade.
„ B. M. Wilson, ditto, 2nd grade.
„ A. Ewing, ditto, 3rd grade, from 30th July 1885.
„ A. B. Smart, Assistant Surveyor, 3rd grade, from 25th February 1885.

Sub-Surveyors on duty.

Babu Madhu Sudan Dutt.
Three others transferred to Field Parties.

Additional Establishment.

Mr. W. Stotesbury, Draftsman.
„ P. J. W. Doran, ditto, from 1st January 1885, and seven others.

ENGRAVING OFFICE.

Mr. C. W. Coard, Superintendent.
„ W. Donaldson.
„ G. G. Palmer.
„ D. L. Mitchell, returned from furlough, 30th March 1885.
„ J. Fulford.
„ T. B. Rodger.
„ A. G. Palmer, returned from furlough, 2nd April 1885.
„ S. M. Coard.
„ A. W. N. James.
„ A. R. Coard.
„ A. D. M. Chamarett.
„ E. C. Ollenbach, and 25 Native Engravers and 1 writer.

Copper-plate Printing Section.

Mr. W. T. Collins, Copper-plate Printer, and 15 native printers and pressmen.

The duties of the Surveyor General's and the Topographical Branch Offices have been carried on by Major M. W. Rogers, R.E.*

The Revenue Survey Branch Office was supervised by Lieutenant-Colonel H. R. Thuillier, R.E., who has carried on all the duties connected with the accounts as well as the correspondence of the branch.

The Drawing and Engraving Offices have been supervised by Major C. Strahan, R.E.

Lieutenant-Colonel W. H. Wilkins, S.C., assisted the Deputy Surveyor General in charge Revenue Surveys in general administration, and continued to hold charge throughout the year of the Map Record and Issue Office.

The post of the Personal Assistant to the Surveyor General was held by several officers :—

Mr. G. H. Cooke up to 1st January 1885;

Lieutenant F. B. Longe, R.E., from 17th January 1885 to 3rd March 1885;

Lieutenant H. M. Jackson, R.E., from 6th May 1885 to 7th September 1885; and

Lieutenant G. B. Hodgson, S.C., from 8th September 1885 up to the present time.

Mr. J. Eccles, M.A., who was appointed to the Survey of India Department by the Secretary of State for India, joined the office on 30th May 1885, and, after undergoing a course of training in the Technical Offices at Calcutta, was transferred to the Dehra Office from 26th July 1885.

MAP RECORD AND ISSUE OFFICE.

The Map Record and Issue Office was under the charge of Lieutenant-Colonel Wilkins until 4th November, when that officer left Calcutta, and the duty devolved on Major C. Strahan, R.E., who has superintended it since then. The number of maps issued during the past year is shown in the following statement:—

Maps issued.	Number.	Value.
		₹
General maps to Government officials	66,396	56,806
Ditto to India Office, London	2,324	3,041
Ditto to Agents	1,887	2,761
TOTAL .	70,607	62,608
Cadastral maps to Government officials	1,65,029	1,23,772
GRAND TOTAL .	2,35,636	1,86,380

The corresponding numbers last year show that there has been an increase of 36,579 in total number of maps issued, and of ₹13,858 in their total value.

2. The revenue section of this office received 620 applications for extracts from original survey records, involving the copying of 3,389 village plans, &c., at a cost of ₹5,844, which was paid by the applicants and transferred to the extra draftsmen employed on this duty.

* Major Rogers reports as follows:—

Mr. Babonau, Registrar, Survey of India Offices, has performed the duties of his office in a most satisfactory manner.

In the Surveyor General's and Topographical Branch Offices, the Head Clerks, Messrs. Francis and D'Rozario, have worked well, the latter having been transferred to Dehra Dun in July, on appointment to the newly-created post of Head Clerk in the Office of the Deputy Surveyor General, Trigonometrical Branch. Mr. J. A. Vallis, Babus Banee Madhub Banerjee, Bama Churn Chuckerbutty, Bheecum Singh, Chuni Lal Dey, Kanti Chandra Sen, with the rest of the clerks, have also done well.

In the Revenue Branch Office the Deputy Surveyor General reports that Mr. A. C. Cunningham, Head Clerk, Mr. E. D. Algar, Head Accountant, and Babu Kali Podo Banerjee, Reference Clerk, have continued to give satisfaction in the discharge of their several duties. The other clerks have all done well.

3. The proceeds of map sales are shown in the following statement:—

Particulars.	Amount.		
	R	*a.*	*p.*
Realised from the resident map salesman, and paid into the Government Treasury	5,726	0	0
* Realised from the mofussil agents, and paid into the Government Treasury	1,021	0	6

4. The details of work performed are as follow:—

	Details.	Numbers.
	Applications received for maps, by letters, indents, and telegrams	3,575
	Letters issued in reply	2,758
	Invoices and receipts issued for published maps	1,934
	Ditto for cadastral ditto ditto	448
	Ditto for extracts from original records for Revenue Surveys	146
	Packets, parcels, and town despatches	2,911
	Packages despatched by rail and steamer	263
†	Published maps coloured for sale and issue	13,353
†	Ditto ditto for other Departments	2,610

5. To Lieutenant-Colonel Wilkins is due the very complete and systematic arrangement of racks, in which space has been provided for all the 1″ standard sheets, the ¼″ engraved atlas sheets, as well as for an immense number of other maps of all scales and descriptions. The cadastral printed sheets are in a separate room, but they are stored in a similar way. The racks extend from the floor to the ceiling, every available square foot of floor space being utilised; to give easy access to the upper parts of these huge racks, galleries have been built connected with one another and with the floor by permanent ladders. Every published map has its own allotted space and numbered rack, and by a reference to a printed index can be obtained in a moment. The cost of the whole has been R13,235. Closed racks kept under lock and key have been provided for the safe custody of all confidential maps; such maps are only issued under the direct orders of the Foreign Office, except in the case of a few privileged individuals.

6. The work in the map-sales office has been well carried on by one of the most experienced clerks in the office. The commission, that was paid formerly to local booksellers and to the late Mr. J. N. T. Wood, the Head-quarters Office agent, has been paid to the extra clerks and duftries who have done the work of the abovementioned agents.

7. The arranging and sorting of all the different kinds of maps has not been quite completed, but very nearly so. The additional racks are finished to all intents and purposes, only a small amount of carpentry or painting still being left undone for want of funds.

8. The catalogues of the atlas sheets of India and of the maps of the Punjab have been completed and final press order given. That for the North-Western Provinces and Oudh is nearly ready for the press.‡

* Some mofussil agents have not yet submitted their accounts, and hence this statement is incomplete.

† *N.B.*—Maps are not coloured in anticipation of requisitions as formerly.

‡ Major C. Strahan reports well of Mr. Byrn, the assistant in charge of the office. Mr. H. R. Vallis, Map Curator, also does the work of map salesman and has performed his arduous duties with entire satisfaction. Mr. Doran has done excellent service in superintending the men employed in making the racks, in sorting and arranging the maps and in preparing the catalogue, and Babu M. S. Dutt, Sub-Surveyor, has rendered good service in the registering of special and original maps.

DRAWING OFFICE.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

9. Perhaps the most important work of Section I of this office is the preparation of the maps on the scale of 1 inch=4 miles which are given as copies to the engravers. During the year under review 36 of these sheets have been dealt with; some have been drawn in outline, others have had the hills shaded in with the brush, whilst others have only had additions or corrections made to them. One European draftsman is being specially trained for preparing maps for the heliogravure process, by which it is hoped considerable assistance may be given to the Engraving Office. The very best style of work is necessary for this process, and great care must be bestowed on the original hand-drawn map if the results are in any way to compete with hand-engraved maps. In order to obtain as far as possible the same or nearly the same sharpness of line it has been found advisable to draw on a slightly larger scale and then reduce by photography; this renders the work of the draftsman a little easier perhaps, inasmuch as it need not be quite so minute, but still the utmost pains must be taken with every individual stroke.

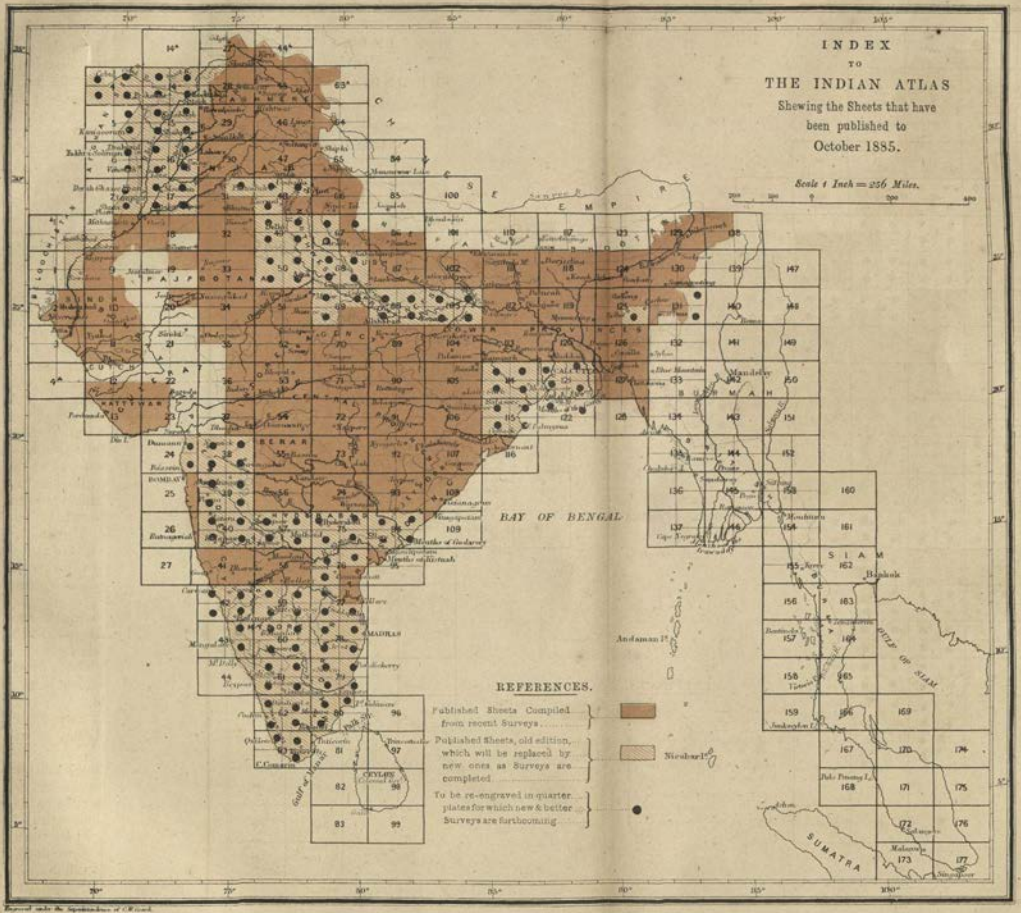
10. The 16 mile maps of districts or provinces which are gradually being engraved are also making good progress. That for the Punjab has been completed in outline so far as the Drawing Office is concerned, whilst the Bengal map has been engraved in outline and brush-shaded hills have been supplied by the draftsmen to the hill etchers. Central India and Rajputana have been kept up to date as far as materials have been received from the Survey parties or very nearly so. Other similar maps of Mysore, Kohat, and Gujarát have been commenced, and are being drawn in such a style that they can be photozincographed in outline and issued as a preliminary edition so as to render them available to the public as soon as possible in a clear and legible form, though of course they will be very inferior, from an artistic point of view, to the final engraved map. An important map was prepared at the special request of the Hon'ble Member, Public Works Department, to show the railways and roads on the North-Western Frontier of India and up to Quetta. This was made by printing those portions of North-Western India which had been finally engraved, leaving all the trans-frontier countries of Afghanistan and Baluchistan blank. On this blank paper were compiled the results of all the latest surveys and the whole was then photozincographed, and now forms the best small scale map in existence of that part of India and the neighbouring countries.

11. The small administration report maps have not even yet been quite completed; the delay has not been through any dilatoriness on the part of the Drawing Office, but in consequence of the large alterations and additions that have been made on nearly all of them by the district officials to whom proofs were sent. This job has been a very tiresome one and has given a great deal of trouble and it will be a source of congratulation when it is finished.

12. Great improvements have also been made in all the index maps; they have many of them been re-drawn and have all been so arranged that they will occupy either a half or a full sheet of foolscap.

13. A map showing the distribution of the seven principal religions in India has been prepared from the results of the last census, in such a way as to admit of its being printed by chromolithography. The method adopted was this. Each district or Native State was taken as a unit and was colored according to the religions professed by the inhabitants, in such a way that the space occupied by each color was in the same proportion to the total space representing the district as the professors of that religion to the total number of inhabitants. The depth of colour also varies so as to show to a certain extent the density of the population.

14. An elaborate model, based on the 32 mile map of India, showing all the hills as well as the scale will allow, has been commenced and every effort will be made to have it ready for the Colonial and Indian Exhibition of 1886, but it is a very heavy task. From the original it is proposed to make a plaster-of-paris mould from which again any number of casts can be taken. It is the first



Published under the Direction of Colonel G. C. Depree R.E. Surveyor General of India
At the Survey of India Office, Calcutta, March 1886.

attempt at anything of the kind and it is hoped it may prove a success. The vertical scale is 12 times the horizontal, hence the highest peaks of the Himalayas are nearly 2 inches high.

15. A large skeleton map of India on the 32 mile scale showing only large rivers, cities and a very rough sketch of the principal hill ranges has also been prepared for the Exhibition under the special direction of the Revenue and Agricultural Department. This has been lithographed.

16. The fair sheets of the Simla Revision Survey on the 24 inch scale were drawn in the early part of the year; it was found that the number of levels taken had been, for want of time, insufficient to enable the contour lines to be drawn in with any degree of accuracy, so the sheets were published without them; during the recess season the contouring has been completed and a second edition will be issued showing level lines at intervals of 50 feet. A guide map on the 8 inch scale has also been drawn from the larger sheets; both have been published by photozincography.

Section II.—Revenue Mapping.

17. In Section II the usual work of examining the fair sheets submitted by the Survey Parties and passing them for press has been carried on. Amongst the special jobs undertaken in this office may be mentioned the maps of a great part of the Nepal Boundary, which were compiled from the old records; they were made into sheets and bound up into one volume with an index map to suit the requirements of the Foreign Office. The new edition of the map of the cantonments of Saugor which was commenced last year has been completed with all the additions and corrections sent in by the Inspector General of Military Works. It was drawn on the 8 inch scale and reduced by photography to the 6 inch scale.

18. A detailed statement of the very numerous tasks performed by this office will be found at page xcix of the appendix.

Section III.—Cadastral Mapping.

19. The establishment of this office during the past year consisted of one Surveyor in charge and six native draftsmen, besides nine extra draftsmen or tracers.

20. The reproduction of cadastral maps is made in two ways, *viz.*, by photo-zincography and by tracing on to prepared paper; in either case the map is transferred to zinc and the process of printing is the same. For very simple sheets, where the village is very small or on which there may be very little detail, it has been found cheaper to trace the maps than to photograph them; by so doing also the Photographic Office is relieved of some of the work which it would otherwise be necessary for it to do, and the supply from the double source obviates the danger of the printing section running short of work. The tracings are made by the nine men above alluded to. The sheets to be photographed are first examined to see that they have been suitably drawn and are then sent to the Photographic Office; the proofs of all sheets are finally carefully examined and all errors are referred to the Deputy Superintendent in charge of the survey party for adjustment. The total number of sheets dealt with during the year under report was 15,734, showing an increase of 146 sheets over the returns of last year; the number of tracings made is less than that of last year by 485, owing to the inability of the Zincographic Office to transfer more than six sheets a day.

21. Of the maps that have passed through this section special mention may be made of the 48 sheets, on the scale of 64 inches=1 mile, of the town of Bassein which have been published during the past season. These sheets form a most minute and reliable map of the town. The plan of Prome township in ten sheets on the same scale has also been received, but too late to enable its publication during the year under report.

22. The publication of the cadastral maps of the following districts has been completed during the past season: districts Ballia and Tarái in North-West Provinces; Hanthawaddy, Pegu and Tharrawaddy in British Burma; and Pooree (Khorda Estates) in Bengal, with the exception of 76 sheets.

23. The publication of the sheets of the Gorakhpur district has been commenced; these maps are neatly and clearly drawn and are by far the best specimens of cadastral maps yet received.

24. For detailed statements of work performed *vide* page civ of the Appendix.*

ENGRAVING OFFICE.

25. Again this year I regret to have to report the death of one of the Native hill etchers; another man has been for nearly the whole year working under Colonel Waterhouse, touching up heliogravure plates, leaving only two Natives in this important branch of the Engraving Office. The result of this is a falling off in the outturn of hill-etching; but, on the other hand, considerably more jungle work has been etched. In the outlining and lettering the amount of work may be considered almost the same as for last year, there having been a smaller amount of the former, but more of the latter.

26. The work of the Printing Office shows a larger out-turn than during any preceding year except during 1883-84, when extra pressure was put on in order to turn out the very large number of certificates and other things connected with the Exhibition. The following small table shows how rapidly the demand for engraved Maps has been increasing; it is now turning out almost as many prints as is possible with the present number of presses; should the work largely increase, more presses must be obtained, but the difficulty will then arise of want of accommodation.

Years.	Total number of Impressions.
1881-82	8,967
1882-83	15,114
1883-84	19,054
1884-85	17,625

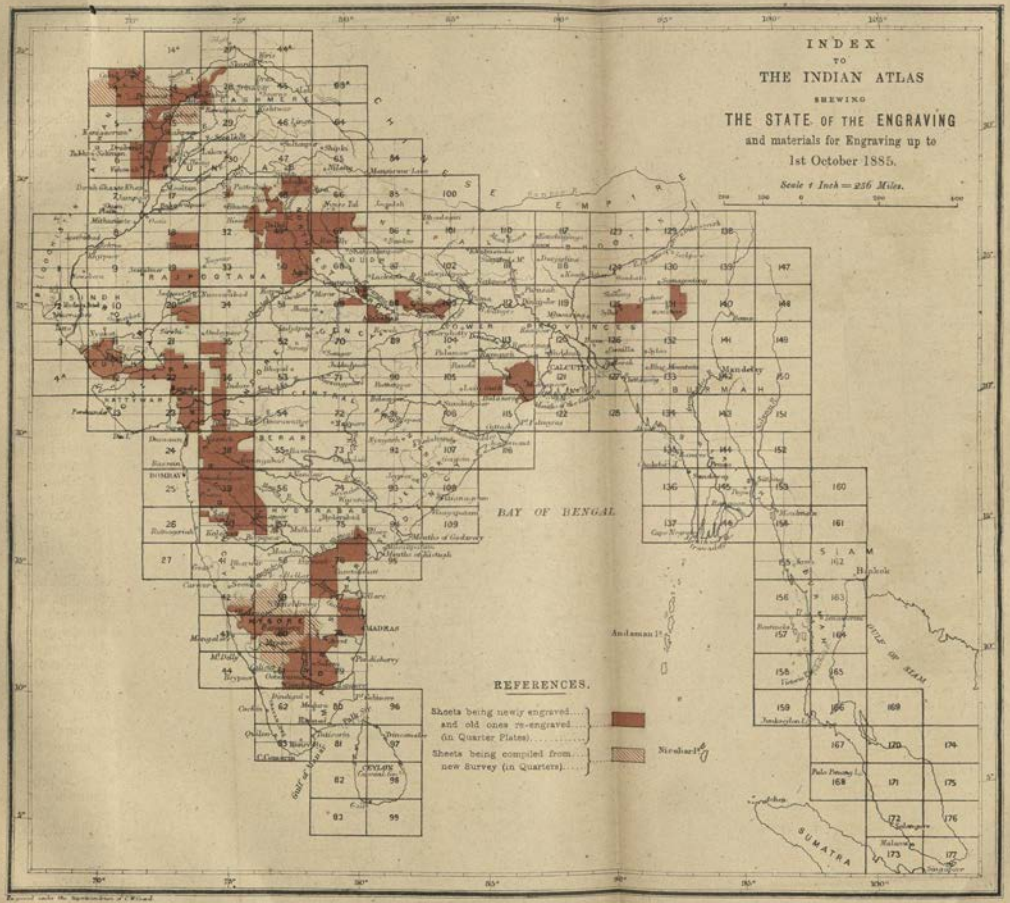
27. Of engraved Maps other than the Atlas sheets, sheet No. 1 of the 32-mile Map of India has been completed as far as drawings were available; of the 6 sheets forming this fine Map Nos. 4, 5 and 6 are complete; No. 1 is complete in outline within the boundary of India and a considerable portion of the heavy hill-etching of the Himalayas is finished; No. 3 is untouched as regards the hill-etching: but the outline is complete as far as reliable materials can be obtained at present. A skeleton Map of India, 64 mile scale, has been completed and published, and the hill-etching in the 16-mile Map of Bengal has been commenced; an 8-mile Map of Berar has also been very nearly completed. Besides the regular Map Engraving, 2 diagrams, one for computing traverses and one for the Punjab Irrigation Department, several scales, the names on 12 Exhibition Medals and titles for 26 heliogravure plates have been engraved. The figures on 21 newly divided theodolite limbs have also been cut for the Mathematical Instrument Office.

28. A very successful reproduction of a quarter atlas sheet by the Electrotyping process was made by Colonel Waterhouse, and it is proposed to adopt this method where it may be necessary to make large corrections on a plate such as changes of boundaries and district names, the correction of which by the ordinary method of cutting out and hammering up from behind might seriously damage the plate. Anything that is incorrect or superfluous can be easily burnished out on the matrix and additions recut on the final plate which is again electrotyped from the matrix. The advantages of this plan are two-fold—one is that the original plate is untouched, and the other that the electrotyping, when once started, goes on without requiring the supervision of skilled engravers who consequently can be employed on other work. The cost of reproducing by this method is so small as to be of no consequence.

29. Eight quarter atlas sheets have been published, fifty-eight are in progress and thirty-seven have been repaired or added to. The total number of plates in hand was 211, and the Printing Office pulled 17,655 impressions. The detailed statement of work performed will be found at page cvi of the Appendix.†

* Major Strahan reports as follows:—
Messrs. McGill and Smylie have each done excellent work as Superintendent of their respective sections. Messrs. Musgrove and Sinclair are specially mentioned as having worked hard and willingly. Mr. Adams is also specially commended in the examining section.
Mr. R. C. D. Ewing, who had held charge of the cadastral office since October 1883, was relieved of his duties by Mr. W. Stotesbury on 17th July, and shortly after proceeded on a year's furlough to Europe. Major Strahan reports that both Messrs. Stotesbury and Ewing have performed their duties most satisfactorily.

† Mr. Coard has superintended the Engraving Office with his usual skill, and his assistants, both European and native, have performed their duties very satisfactorily.



Published under the direction of Colonel G. C. DePree, R.C., Surveyor General of India,
at the Survey of India Offices, Calcutta, February 1886.

THE PHOTOGRAPHIC OFFICE.

30. Lieutenant-Colonel J. Waterhouse was on tour from 26th September till 19th November 1884, and then held charge of the Photographic Office till the 15th July, when he proceeded on privilege leave for three months. On both occasions the duties of the office were carried on by Major M. W. Rogers, R.E.

Personnel.

Lieutenant-Colonel J. Waterhouse, R.S.C., Assistant Surveyor General, in charge.
Lieutenant J. M. Fleming, S.C., Assistant Superintendent, from 3rd July.

NEGATIVE SECTION.

Normal Establishment.

Mr. J. Mackenzie, Photographer.
„ C. DeCruze, Assistant ditto.
Ismail Khan, ditto ditto.
2 Negative Retouchers, 2 Glass-cleaners and 1 Bhistee.

Cadastral Establishment.

Mr. C. Marshall, Photographer.
„ L. Lagnier, ditto.
„ F. Lloyd, Assistant ditto.
3 Assistant Photographers, 3 Negative touchers, 5 Glass-cleaners and 1 Bhistee.

PHOTOGRAPHIC TRANSFER PRINTING SECTION.

Normal Establishment.

Mr. J. Harrold, Photographer.
Habibul Hossain, Assistant ditto.
2 labourers.

Cadastral Establishment.

Mr. R. George, Photographer, in charge of the Silver Printing Section in addition.
2 Assistant Photographers and 2 labourers.

SILVER PRINTING SECTION.

Normal Establishment.

Mr. G. G. Dempster, Photographer, working in the Negative Section (Normal).
1 Assistant Photographer and 1 labourer.

HELIOGRAVURE SECTION.

Normal Establishment.

Mr A. W. Turner, Photo-Engraver, from 1st October to 31st December 1885, and 1st April to 30th September 1885.
Babu Joy Kristo Shaw, Engraver, drawing his pay from the Engraving Office but working in this Office from March 1885 to 30th September 1885.
1 Assistant Photographer, 1 copper-plate printer, and 4 pressmen.

COLLOTYPE SECTION.

Normal Establishment.

1 Printer, 1 glass-cleaner, and 1 pressman.

ZINC PRINTING SECTION.

Normal Establishment.

Mr. B. Mackenzie, Zincographer.
1 Writer, 4 zinc-correctors, 5 zinc-printers, 4 spongemen, 17 pressmen, and 3 zinc grainers.

Cadastral Establishment.

Mr. J. Watson, Zincographer.
„ E. A. LeFranc, ditto.
„ J. B. Mackenzie, Assistant Photographer, working in the Zinc Printing Section from May to 30th September 1885.
9 zinc-correctors, 1 writer, 9 zinc printers, 6 spongemen, 11 grainers, and 30 pressmen.

GENERAL OFFICE ESTABLISHMENT.

Normal Establishment.

Mr. W. Moore, Store-keeper.
Babu Kanny Lall Sen, Clerk and Accountant.
1 Clerk.

Cadastral Establishment.

Mr. H. Haward, Head Assistant, in charge Collotype Section.
1 Clerk.

APPRENTICES.

Normal Establishment.

C. Meade, working in the Silver Printing.
J. T. Meade, working in the Collotype Section.
S. U. Ravenscroft, working in the Zinc Printing (Cadastral).
P. C. Michael, working in the Negative Section.

31. The out-turn of the office, as shewn in the annexed abstract, has been unprecedentedly large in every department. In the Normal sections the number of subjects reproduced has risen from 941 (531 departmental and 390 extra-departmental) to 1,702 (853 departmental and 849 extra-departmental). The number of zinc plates printed shews an increase of 213, with 20,437 more pulls and 25,526 more impressions than last year. The amount of silver printing has been considerably larger. In heliogravure, electro-typing and photo-collotype printing there has also been a large increase, and these processes are now beginning to be fairly established.

32. In the Cadastral sections there has likewise been a considerable increase of out-turn, the number of sheets printed being 5,160, with 170,906 pulls, against 5,083 sheets, with 133,191 pulls, last year.

33. The total expenditure of the office during the year has amounted to R1,08,048, against R1,27,763 of the previous year, and the value of the work done to R1,48,738, shewing a balance in favour of the Department of R40,690. The actual expenditure from the Budget grant has been R84,259 as against R89,502 of last year; but it should be remarked that in last year's accounts pay of establishment for 13 months was included, having been actually drawn during the survey year. The present accounts therefore only show 11 months' pay of establishment. Including the 12 months' pay for the year under report, the expenditure against the Budget grant would be R89,454 and the total expenditure R1,13,243 against R1,22,568 for the corresponding 12 months last year. In any case the expenditure has been less than last year, while the amount and value of work done has been much larger.

General Abstract of Work done between 1st October 1884 and 30th September 1885.

Specification of Plate or Print.	Number of Sheets, Sections, or Subjects.	Negatives.		Photozincographic Printing.					Silver and other Printing.			Heliogravure and Electrotyping.					Photo-collotype.		Value.
		Number of Negatives (Direct).	Number of Negatives reversed and transferred.	Number of Photo-transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.	Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.	
																			R a. p.
Departmental Maps and Plans .	833	1,633	49	1,533	551	617	68,101	70,402	324	312	36	25	47	1,847	13	2	7	265	43,216 13 7
Cadastral Maps . . .	5,156	3,490	...	3,490	5,160	5,160	1,70,906	1,70,906	...	...	...	...	...	...	...	...	...	...	74,325 4 0
Extra Departmental Maps and Plans	849	878	13	871	285	309	53,808	88,968	3,582	...	...	2	5	2,855	...	...	48	11,374	30,324 8 4
Total .	6,858	6,001	62	5,900	5,996	6,086	2,92,815	3,30,276	3,906	312	36	27	52	4,702	13	2	55	11,639	1,48,066 9 11

34. The ordinary work of the office, both departmental and extra-departmental, has been of the same miscellaneous character as usual, and there is nothing specially worthy of remark beyond the very large increase in the number of standard sheets reproduced. Last year the number was very much under the average, being only 253, but this year 460 sheets have been reproduced, and 384 printed off.

35. Lieutenant-Colonel J. Waterhouse reports that with the assistance he has had from the permanent appointment of Mr. A. W. Turner from 1st April, considerable progress has been made with the various processes of heliogravure by the electrotyping and etching methods: 79 plates have been produced and 4,702 copies printed in the copper-plate press. These have principally been plates of the series of photographs of Indian Art-work taken in the Calcutta Exhibition, of which the first part, containing 6 photo-engravings of wood carvings, was published. Considerable attention has also been given to the reproduction of maps and some very successful experiments have been made in reproducing brush-shaded maps by the photo-etching process. It will yet take some time before these processes can be brought into systematic use for the reproduction of maps for publication, because a special staff of skilled draughtsmen will be required to draw the original maps in a suitable style to imitate hand-engraving, with the hills either in vertical pen-and-ink hachures or brush-shaded. A commencement has however, been made, and it is hoped that this work will steadily progress. There is no doubt that with suitable original drawings the heliogravure processes could render immense service in the cheap and speedy production of engraved maps.

36. A process for preparing blocks suitable for printing with type by means of a combination of photography and electrotyping, has also been introduced with some success, and several blocks of the new departmental seal and of vernacular titles for cadastral maps, as well as a small map of District Darjeeling, were produced by means of it. Some very promising results have also been obtained by preparing similar blocks of subjects in half tones, but these require great care and skill in printing.

37. Besides its use in connection with heliogravure and photo-block printing, the process of electrotyping has been applied to the duplication of the engraved sheets of the atlas of India, either for making corrections or for obtaining an electrotyped plate of the outline of certain sheets on which the hills might be added by heliogravure, pending the engraving of the hills on the original plate. This application of electrotyping will be very valuable and has long been a desideratum.

38. The photo-collotype process has also made good progress and upwards of 11,000 impressions have been printed during the year, among them copies of two plates of an ivory-carved casket for the Indian Art Journal, three plates from photographs for the Asiatic Society and two plates for the North-Western Provincial Gazetteer.

39. Full details of the improvements made in the various processes during the year will be found in Lieutenant-Colonel Waterhouse's report given in the

Appendix, also the detailed statements of the departmental and extra-departmental work done, and of the expenditure and value of the work done during the year under report.

40. Lieutenant-Colonel Waterhouse has also added a few notes of improvements he noticed in his visits to the Antwerp Exhibition, the Inventions Exhibitions in London and the Ordnance Survey Office, Southampton, when on privilege leave.

41. Lieutenant J. M. Fleming, S.C., Probationary Assistant Superintendent, 2nd grade, joined the office in July, and has been under instruction in the various processes connected with the work of the photographic and lithographic offices.*

THE LITHOGRAPHIC OFFICE.

42. Lieutenant-Colonel J. Waterhouse was on tour from 26th September to 19th November 1884, and from the latter date held charge of this office until the 18th July, when he proceeded on privilege leave for three months. On both occasions he handed over temporary charge to Major C. Strahan, R.E.

Personnel.

Lieutenant-Colonel J. Waterhouse, S.C., Assistant Surveyor General in charge.
Mr. H. L. Lepage, Head Assistant.
Munshi Mahomed Azim, } Draftsmen.
" Sobhan Buksh, }
Babu Ambica Churn Mookerjee, and } Draftsmen.
23 others,
Mr. D. Dess, Head Lithographic Printer.
" B. Wilson, Assistant ditto, and 74 others.
" E. DePyvah, Head Type Printer, and 25 others.
Five clerks and 12 others.
Mr. G. A. LeFranc, } Apprentices.
" E. Dowling, }
" J. Seaward, Extra Apprentice Printer.

43. The lithographic work performed during the year, as shown in the annexed abstract, shows a very large increase over last year. The number of subjects printed off amounted to 749, of which 227 (including 81 forms) were departmental and 522 extra departmental, the total number of copies being 367,976 as against 185,196 of last year, or nearly double. The type work has also largely increased, the number of items set up being 5,687 against 4,184, and the number of copies printed off 464,976 against 351,347 of the previous year. This large increase, both in lithography and type work, is to a great extent due to the increased number of forms, many of which hitherto printed at Dehra are now to be printed here.

General Abstract of Out-turn and Value of Work performed.

Description of maps.	Lithographic Printing. Number of sheets or subjects.	Number of stones.	Number of colored copies.	Number of uncolored copies.	Type Printing. Number of pages or items.	Number of copies.	Total number of pulls.	Number of copies.	Value. R a. p.	Remarks.
Departmental Work.										
General maps	19	26	948	540	...	...	4,820	1,488	1,963 12 8	
	8	14	...	...	...	...	...	...	927 0 0	Not yet printed.
Provincial maps	10	5	...	5,000	...	...	3,000	5,000	240 6 10	
	6	6	...	...	...	...	...	...	356 12 0	Ditto.
District maps	4	4	...	411	...	...	411	411	317 8 10	
	3	4	...	...	...	...	...	...	718 10 0	Ditto.
Plans of Cantonments and Cities	3	5	108	75	...	...	502	183	132 10 8	
Atlas sheets	3	3	...	...	...	...	...	...	454 12 0	Ditto.
Standard sheets	5	5	...	1,410	...	...	1,410	1,410	1,321 14 1	
	20	20	...	...	...	...	...	...	5,380 6 0	Ditto.
Index maps	8	14	2,700	450	...	...	6,110	2,850	617 4 10	
Miscellaneous maps	56	73	1,661	27,946	...	...	18,948	29,607	1,958 15 11	
Departmental forms	73	73	...	125,257	...	...	125,316	125,257	3,240 4 2	
	8	8	...	...	...	...	...	...	63 4 0	Ditto.
Total	277	260	5,417	160,759	...	...	160,522	166,206	22,767 9 0	
Work done for other Departments	522	433	16,133	183,637	...	...	171,696	201,770	24,266 12 0	
Total of Drawing and Printing in Lithographic Office.	749	693	21,550	346,426	...	...	332,218	367,976	47,034 5 0	
Work done in Type Department	...	...	...	...	5,687	464,976	760,670	...	13,610 2 0	
Total	...	...	...	...	...	...	...	...	60,644 7 0	
Deduct value of transfers, &c., already included in the cost of several lithographed maps, &c.	...	...	...	...	...	...	...	...	1,742 3 6	
Balance	...	...	...	...	...	...	...	...	58,902 3 6	

44. The introduction of the hand power lithographic machine, of which the receipt was noticed in last year's report, has been of invaluable assistance in

* Lieutenant-Colonel Waterhouse again reports very favourably of his European Assistants, Messrs. Howard, A. W. Turner, J. Mackenzie, B. Mackenzie, J. Watson, J. Harrold, C. Marshall, R. George, L. Lagnier, E. A. LeFanc, G. Dempster, J. Lloyd, and W. Moore, as well as of Babu Kanny Lall Sen, Head Clerk, who have all continued to work with their customary zeal and steadiness. The other native clerks and draughtsmen have also worked well.

clearing off this large amount of additional work without any increase in establishment, the out-turn being 1,000 copies a day.

45. At the close of the year a demy broadside Bremner Steam Type Printing machine, by Harrild and Son, was received and set up in the Mathematical Instrument Department, being worked by the engine there without any extra cost. This machine also will be of great assistance in coping with the large increase in type work for departmental forms. The out-turn is about 4,000 copies a day.

46. The principal piece of work completed during the year has been the Contour map of India in 6 sheets on the scale of 1 inch=32 miles. It is now ready for printing. A bold Outline map of India on the same scale has been prepared for Exhibition and other purposes, and is also ready for printing. A commencement of a Military map on the same scale has been made. It will be in 12 sheets, printed in four colours: outline and names in black; streams and other hydrographic details in blue; hills in brown; and military information and details in red. Three sections are in hand, but the work will probably take some years to complete.

47. A map showing the Distribution of the principal Religions in India and British Burma, on the scale of 80 miles to the inch, has been prepared and will be printed in eight colours.

48. The drawing of the second sheet of the map of the Nizam's Dominions, mentioned in last year's report, was completed on stone in excellent style by Mr. Cunningham.

49. Six of the new standard sheets of Oudh on the 1 inch scale have been drawn and three published. Three sheets of District Mymensingh on the same scale were drawn, but none printed.

50. The Extra-departmental work again shows a considerable increase and has been of the usual miscellaneous character, including a large number of plates for the Archæological Survey Reports, Meteorological Memoirs, coloured maps for the Geological Survey, &c., as shown in the tables given in the appendix. The total number of subjects received was 522, of which 171,696 copies were printed, the value of the work being R24,266-12.

51. The tabular statements and report showing the details and cost of the work done will be found at page cxxvii of the Appendix.*

MATHEMATICAL INSTRUMENT OFFICE.

52. During the financial year 1884-85 the work of this office has steadily increased and great activity has prevailed in all its branches.

Personnel.

Major M. W. Rogers, R.E., Assistant Surveyor General, in charge.

Workshop Branch.

Mr. T. Bolton, F.S., Sc., Lond., Mathematical Instrument-maker.
Mr. F. Marshall, Assistant Mathematical Instrument-maker.
64 Artificers on permanent establishment.
122 (on an average) Artificers on the contingent and temporary establishment.
3 Apprentices from 1st September 1884.

Store Branch.

Mr. G. R. Alderman, Instrument Store-keeper, from 1st April to 19th September 1884.
Mr. C. O. Gray, from 20th September 1884 to 31st March 1885.
Babu Womesh Chunder Chowdhry, Material Store-keeper.
Packing sircar.
Packers.

Office Establishment.

Mr. M. O'Brien, Head Clerk,
" C. O. Gray, from 1st April to 19th September, } 2nd Clerks.
" J. Fink, from 8th October to 19th March, } 2nd Clerks.
" W. Campagnac, from 20th to 31st March, } 2nd Clerks.
6 Other permanent Clerks.

A thorough stock-taking of all stores and instruments was undertaken and the stock of the office was checked and verified in a most complete manner. The final results being as follows:—

	Excess.		Deficit.	
	No.	Value.	No.	Value.
		R a.		R a.
Serviceable instruments.	518	633 13	271	1,746 1
Repairable instruments.	201	648 10	1,941	1,993 5
Materials . .	...	2,839 0	....	277 0
TOTAL .	...	4,021 7	...	4,516 6

Advantage was taken of the dismissal of the store-keeper to place the store branch on a more satisfactory footing, the repairable instruments being now under the charge of the Mathematical Instrument-maker.

* Lieutenant-Colonel Waterhouse again reports very favourably of the conduct of the European assistants. The native clerks and draftsmen have also worked satisfactorily.

53. As was mentioned in paragraph 44 of last year's report, an extra grant of R300 per mensem was temporarily sanctioned by Government, in order to increase the workshop establishment and make an attempt to utilise the ever-increasing accumulation of repairable instruments. This extra establishment has been working during the whole of the year under review, and at its close a report was sent in showing that in 1884-85, for the first time, the number of repairable instruments in store has decreased by a value of R20,000 notwithstanding that instruments of a value of R28,000 were returned in the usual course, which but for the extra grant would have gone to swell the number of repairable instruments accumulated in the stores. At the recommendation of the Surveyor General, the grant has been extended for a further period of two years.

54. During the year a new element has been introduced into the workshop by the sanction of Government being given to entertaining three European or Eurasian apprentices on somewhat the same terms as have been sanctioned for the Cossipur workshops. These lads are bound for five years and are receiving a thorough training in all the branches of the manufacture and repair of Mathematical Instruments, and under the able instruction of the Mathematical Instrument-makers they are already becoming useful, and as far as the present apprentices are concerned, the scheme bids fair to be a complete success.

55. A fine circular dividing machine by Troughton and Simms, which had been obtained from England some years ago for the Madras Public Works Department Workshops and had lain there unused, was, at the instance of the officer in charge, transferred to the Mathematical Instrument Office where it was set up and has been in use during the greatest portion of the year, enabling the workshop to re-divide the limbs and verniers of many damaged theodolites which would otherwise have had to be rejected or sent to England to be re-divided at a large expense.

56. The stock was increased by a total receipt of 27,260 instruments amounting in value to R1,35,414, the detail of which is as follows: 6,431 instruments valued at R56,462 were received from England; 4,751 were locally purchased at a cost of R8,695; 8,555 were manufactured in the workshop at a cost of about R23,822; 4,123 valued at R46,407 were received by departmental exchange, of which 1,802 were serviceable and 2,321 were repairable. Further 3,219 instruments forming part of the repairable stock were repaired on the premises and rendered fit for future issue at a cost of R21,727, which, after repair, were valued at R67,629. This last item, which is nearly double that of last year, is principally due to the extra grant before mentioned.

57. The issue of instruments to various departments during the year amounted, in number, to 27,643 and in value to R1,61,5:0 and in addition work to the amount of R12,437 was also done; the detail of these issues will be found in Table I at page cxxxi of the appendix. The number of theodolites and levels issued was 108 and 113 respectively, of which 86 of the former and 69 of the latter were repaired and made serviceable from the repairable stock. These numbers show an increase over last year's issue.

58. Table II, page cxxxii, appendix, shows the number and cost of the principal instruments purchased in the local market; their value is very nearly the same as that of last year and the class is the same, *i.e.*, chiefly instruments of country manufacture such as plane tables, sight rules, &c.

59. Tables III and IV, pages cxxxii and cxxxiii, appendix, show the general work done in the workshop, manufactures and repairs: the value of the manufactures is slightly in excess of last year's, whilst the value of repairs shows an increase of R8,000.

60. The Profit and Loss account of the workshop shows a profit of R5,587. This is due to the new system of fixed percentage and labour charges, and to the consequent necessity of departing from the old custom of arranging the prices of work so as to show no profit. The charges for work have been kept as low as possible, as is shown by the very small percentage of profit realised on such a large establishment.

61. The cost of the remaining portion of the establishment, including supervision, packing expenses, office accommodation, &c., was about R19,000 which may be considered as representing the expenses connected with the receipt and issue of about R54,000 instruments valued at about R2,94,000.*

* Major Rogers reports that Mr. Bolton and Mr. Marshall have ably superintended the workshops, &c. Mr. Gray and the clerical and store establishments have continued to work well.

THE TRIGONOMETRICAL BRANCH OFFICE.

DEHRA-DUN.

62. The sections under which the work of this office will be reported on are as follow:—

(1) Superintendence, Correspondence, Accounts, Stores, &c.
(2) Computing.
(3) Type-printing.
(4) Drawing and Compiling.
(5) Photo-zincography.
(6) Photo-heliography.
(7) Miscellaneous, Meteorology, Explorations, &c.

63. The principal work of this office is the final reduction and publication of the triangulation in all parts of India, including the principal and secondary operations of the Great Trigonometrical Survey. Most of the publications being necessarily of a technical nature and the office being located at a considerable distance from Calcutta, it has been a great advantage that it possesses small printing, drawing, and photo-zincographic establishments, without which the accuracy of the technical details could not have been well maintained, while inaccuracy would have rendered the publications worse than useless. The office has also a depôt of instruments and stores attached to it chiefly of the higher class of instruments appertaining to the Great Trigonometrical Survey of which it was the headquarters. Among the instruments are, besides several large theodolites, the compensation bars and apparatus for the measurement of base lines. Owing to the completion of the principal triangulation, these beautiful instruments and apparatus have for several years been lying in store unused. It is in contemplation to have them all thoroughly examined, and, where necessary, cleaned, very shortly. For this purpose and for the maintenance of this valuable property in proper order as well as for keeping a certain proportion of the officers of the Department familiar with the adjustments and use of instruments of precision, a small temporary observatory capable of accommodating six large

Personnel.

Colonel C. T. Haig, R.E., Offg. Deputy Surveyor General, in charge of (1), (4), (5), (6), and partly of (7).
W. H. Cole, Esq., M.A., Deputy Superintendent, 3rd grade, in charge of (2), (3), and partly of (7).
Lieutenant S. G. Burrard, R.E., Offg. Assistant Superintendent, 1st grade.
J. Eccles, Esq., M.A., Assistant Superintendent, 2nd grade (joined 28th July 1885).

(1) *Correspondence, Accounts, Stores, &c.*

Mr. C. Wood, Surveyor, 1st grade.
„ J. Bond, Surveyor, 4th grade (transferred to Rajputana Party 1st July 1885).
Mr. F. A. D'Rozario, Head Clerk (joined 27th July 1885).
Sub-Surveyor Visaji Raonath Gadbole (1st December 1884 to 7th September 1885).
Computer Mizaji Lal (transferred to this section on 7th September 1885).
3 Native Writers.

(2) *Computing Section.*

Mr. C. Wood, Surveyor, 1st grade.
„ H. W. Peychers, Surveyor, 3rd grade.
Mr. J. Bond, Surveyor, 4th grade.
Babu Gunga Pershad, Computer.
„ Kally Mohun Ghose, „
„ Kally Coomar Chatterjee, „ .
and 14 other native computers of whom 5 were appointed about the beginning of September 1885.

(3) *Type-Printing Section.*

Mr. B. V. Hughes, Printer.
13 compositors and apprentices.

(4) *Drawing and Compiling Section.*

Mr. G. W. E. Atkinson, Surveyor, 1st grade.
Mr. C. H. McA'Fee, Surveyor, 4th grade (joined 28th February 1885).
Mr. H. Sindon and 5 other draftsmen.
19 Apprentice draftsmen and map colorists.

(5) *Photo-zincography Section.*

Mr. C. G. Ollenbach, Zincographer.
„ C. Dyson, Photographer (retired on 22nd September 1885).
Mr. C. F. Guthrie, Photographer (transferred to this section on 22nd September 1885).
1 Assistant Photographer, 2 native draftsmen, and 1 native assistant draftsman, 1 native map-keeper.

(6) *Photo-heliography Section.*

Mr. L. H. Clarke, Surveyor, 2nd grade, Solar Photographer.
Mr. C. F. Guthrie, Assistant to Solar Photographer till 22nd September 1885.

(7) *Miscellaneous, Meteorology, Explorations, &c.*

Mr. D. Atkinson, Surveyor, 1st grade (1st October to 31st December 1885).
Mr. W. W. McNair, Surveyor, 4th grade (1st October 1884 to 15th February 1885; 1st July to 30th September 1885).
Mr. W. J. Cornelius, Assistant Surveyor, 1st grade (1st July to 30th September 1885).
Mr. C. G. S. Wood, Assistant Surveyor, 3rd grade.
Mr. W. V. Skilling, Assistant Surveyor, 3rd grade (joined 24th November 1884).
Mr. G. H. Powell, Assistant Surveyor, 3rd grade (joined 18th March 1885).
Sub-Surveyor Ahmad Ali Khan (transferred to Himalaya Party on 1st July 1885).
Rai Bahadur Kishan Sing, Milmwal, Explorer.
Rinzin Nimgyal, Explorer.
Abdul Khaliq, Explorer (on probation from 1st September 1885).

instruments, including a zenith sector and a transit instrument such as are employed respectively on the latitude and longitude operations not yet completed, has been erected at a small cost, and the transit room of the old observatory, hitherto used only for the storage of the printed professional and synoptical volumes of the Trigonometrical Survey, has been utilized for the accommodation of two other instruments. The compensation bars will be taken out and a short base line will be measured on the Dehra office estate.

64. The correspondence and accounts of the Trigonometrical Branch call for no special mention, beyond stating that the work in connection with the protection of stations has continued to be carried on as before. During the year under report, 75 new stations (including 16 beacons on the east coast) have been added to the number under protection; and 648 stations have been repaired by district officers at a cost of ₹3,154. Of the 328 districts from which reports were due, those for 58 were not received.

65. (2) COMPUTING SECTION.—During the past year the final reduction and publication of the various operations of the Great Trigonometrical Survey have steadily proceeded. Among the items specially worthy of note may be mentioned the South-West Quadrilateral, with the reduction of which good progress has been made. The final reduction of the latitude observations is now drawing to a close; and the preparation for passing the results through the press is being commenced. The principal triangulation of the Southern Trigon having been already reduced to final terms, the secondary triangulation of this large section, involving also all Colonel Lambton's triangulation in Southern India, is in course of treatment. The remaining work of the computing office is of a miscellaneous character as will be seen on reference to the appendix. The stock of auxiliary tables of this Department having been exhausted, a new edition, revised and extended, is in course of preparation.

66. (3) TYPE-PRINTING SECTION.—As regards the publications of the office, Synoptical Vol. XIIIA, containing the reductions and details of the South Párasnáth and South Malúncha series of the South-East Quadrilateral, has been completed and sent to the binder. The whole of the triangulation of the South-East Quadrilateral now stands completed. Of the North-West Quadrilateral the volume containing the description of the reductions and details of the Jodhpore and East Sind Meridional Series, or Volume IV A, Supplement to Volumes III and IV of the *Account of the Operations of the Great Trigonometrical Survey of India*, is in an advanced state and may be in the hands of the binder early next year. The corresponding synoptical volume is also in the press and will probably be completed some time next year. The whole of the triangulation of the North-West Quadrilateral proper will then be disposed of. The triangulation effected in Afghanistan, compiled for the press by Major Holdich and Colonel Leach, which was printed in this office, has been considered as a supplementary volume to Synoptical Volume I, the Great Indus Series, on which the triangulation depends, and has been designated in consequence Synoptical Volume $\frac{I}{A}$. This volume is ready for the binder, except as regards one of the charts. Of the North-East Quadrilateral there remain the Synoptical Volume of the Assam Longitudinal Series, which is in course of printing, and that of the North-East Longitudinal Series which cannot be taken in hand till the results of the operations along the North-East Frontier are received. I regret to learn from Colonel Tanner that he anticipates two years will elapse before he can supply these.

A pamphlet of Spirit-levelled Heights between Kalyán and Sironj has been published.

Besides the above there are in the press the details of the principal triangulation of the Southern Trigon, the Electro-telegraphic Longitude operations, the Spirit-levelled Heights between Bombay, Madras and Kárwár, and a good deal of work of a miscellaneous character, as will be seen on reference to the appendix.

67. (4) DRAWING SECTION.—The details of the work done in this section will be found in tabular form on page cxxxviii of the appendix, and they will be found to contain the following on which a few remarks are necessary.

68. *Map of Turkistan.*—As additional information was to hand in connection with all four sections of this map, and as the Russo-Afghan boundary was engaging much attention, it was thought advisable, although the new material

was scant, to prepare a new confidential edition rectified as far as possible.

69. The rectifications consisted of alterations in, and additions to, the routes across the Kura Kum Sands (chiefly in sheet 1); the rectification of the geography of Darwáz and the courses of the Oxus, Bartang, and Aksu rivers (sheet 2); the rectification of the country in the vicinity of the Russo-Persian and Afghan boundaries (sheet 3), for which much useful information was obtained from an English translation by Lieutenant Burrard, of the account (in German) in the Mittheilungen of Lessar's travels in Badghis and the neighbourhood of Sarakhs and Herat; the correction of the geography of a portion of Shignan, and the insertion of Mr. McNair's explorations in Eastern Afghanistan and Kafiristan, and of the work done by the surveyors with the Zhob Valley Expedition (sheet 4).

70. Of the level charts three more have been published, of which two are new and one is a 3rd edition, and four others are in progress. Seventeen graticule sheets, of which one was on the 16 inch scale comprising 8° of longitude and 4° of latitude, and 16 on the 8 inch scale comprising 4° of longitude and 2° of latitude, were prepared in connection with the comprehensive scheme embracing the Trans-Indian frontier series of maps. Three other sheets are in progress.

71. (5) PHOTO-ZINCOGRAPHY.—The details of the work performed by this section during the year will be found in tabular form at page cxli of the appendix and need no special mention here. It will be seen in the tabular statement of the accounts of this section at page cxliv that the value of the work done exceeds the expenditure by R9,827-12.

72. The amount realized during the year and paid into the treasury on account of maps sold is R2,009-9-7, of which only R346-9 are included in the sum of R9,827-12 above mentioned.

73. (6) PHOTO-HELIOGRAPHY.—Photographs of the sun for the Solar Physics Committee, South Kensington, have been taken as usual throughout the year daily except on 81 days on which the sun was not visible.

74. It was stated in paragraph 64 of last year's Report that "the large photo-heliograph for taking sun-pictures 12 inches in diameter has not given satisfactory results," but the cause of failure was discovered to lie chiefly in over exposure, and from February 1885 good pictures have been regularly obtained.

75. The exposure is regulated by an adjustable slit in a screen that is shot across the field near the focus by releasing a spring, and it was found that by reducing the width of the slit to 5 hundredths of an inch and sometimes less when the sun is high, and carrying on the chemical intensification of the negative to a maximum, good pictures can be taken with tolerable certainty.

76. The 8 inch and 12 inch pictures are required for different purposes, *viz.*, respectively for measuring the areas of spots and faculæ and for studying the mottling or granular appearance of the normal photo-sphere and structure of the penumbra of the spots.

77. The instrument by which the areas are measured at the Greenwich observatory is only suited to pictures on the 8 inch scale which are considered too small for the study of the structure of either the mottling or the spots. It is to be regretted that the large photo-heliograph cannot be utilized both for the production of 8 inch as well as 12 inch pictures, so that one observatory might suffice for both requirements. Colonel Haig is giving his attention to this matter in the hope of being able to effect economy, but it is at present an open question whether the alterations to the large instrument necessary for the facile production of pictures on the two scales can be effected at a cost which would in the end be a real saving.

78. The usual table of working facts and tabular statements of cost as well as of *percentages* regarding daily visibility of the sun and presence of spots and faculæ, and also a comparative statement of invisibility at Greenwich and Dehra, will be found in the appendix, pages cxliv and cxlv..

79. (7) METEOROLOGY.—The usual tabulated results of the meteorological observations will be found in the appendix. They call for no special remark. The cost of these observations is included in that for the computing section: the amount debitable to the Meteorological Department for work done for it during the year is R330.

Explorations.—Besides the survey of the country north-east of Kinchinjanga, the account of which will be found in Colonel Tanner's report in the appendix, pages xlviii, no explorers brought in any work during the year under review. One explorer, however, has just reported his return to India and another is still out.*

* Colonel Haig and Mr. Cole make special mention of the services rendered by Messrs. Wood, Atkinson and Peychers, and Baboo Gunga Pershad, and report favourably on all the other assistants attached to the Trigonometrical Branch Office.

APPENDIX.

EXTRACTS

FROM

THE NARRATIVE REPORTS OF THE EXECUTIVE OFFICERS

IN CHARGE OF

THE SURVEY PARTIES AND OPERATIONS.

Extract from the Narrative Report of MR. A. D'SOUZA, *Officiating Assistant Superintendent, 1st grade, in charge Coast Party,—Season 1884-85.*

The programme of the season's operations was a continuation of the work done during the two previous field seasons, *i.e.*, furnishing points of reference for the operations of the Marine Survey by building beacons on the coast at intervals of 5 to 15 miles.

The country having been previously triangulated, it was necessary to search for the old stations of the series; and I was fortunate in being able to find out and identify very nearly all the stations of the inland flank and also some on the coast which were on hill-tops; sufficient data was afforded by the stations which were identified to form bases for the triangulation needed to determine the positions of the beacons, light-houses, and other conspicuous landmarks.

Mr. C. D. Potter was entrusted with the approximate work, searching out the old stations, and building beacons and stations; and in order to give him a fair start, I undertook the selection and building of the first beacon. In selecting a site for this beacon, so as to form one of the series previously built, of which that at Sonapur was the last, the site of the station of Kovita was chosen, which is on a commanding high ground and one of the most conspicuous landmarks on the coast after leaving Sonapur. A beacon, 24 feet in height, was accordingly built over the markstone, and on its completion, sufficient work having been prepared by Mr. Potter, I commenced my final observations, while he pushed on with the approximate work. In work of this nature, where the person conducting approximate operations has to select and build stations as well as beacons 15 to 24 feet in height, and the rate of his progress mainly depends upon the facility of obtaining the requisite material for his building operations, the observer very soon gains on him and is unable to work until the stations have been prepared for him to observe from. This would have been the case with us, had I not taken up the work of selecting and building some of the stations myself, in order to give Mr. Potter time to prepare the ground ahead. In this manner we proceeded without loss of time and reached Bimlipatam about March, when I received your orders to send him to inspect and report upon the beacons and stations which had been destroyed on the Pooree coast.

As the absence of Mr. Potter, who was my only assistant, would have materially affected my progress, he was detained till the work had advanced 40 miles beyond Vizagapatam. Then after selecting the sites of four beacons, I made over the building of them to him, with instructions to proceed to Pooree upon their completion.

Forty miles of coast line now remained to be completed, and as I approached the town of Cocanada, I found the country densely covered with fruit trees of all descriptions, so that my work was seriously retarded by my clearing. Considerable difficulty was also experienced in identifying the old stations, the country being exceedingly flat and woody.

The order to continue the triangulation further south was received about this time, but too late to recall Mr. Potter, who had, it was believed, already taken his passage and started for Gopalpur. I, however, directed him to return after the completion of the work at Pooree. I reached Coringa about the 18th of April, and selected the side Munjir Station to Goripudi Station for the base of continuation and carried on a new series of triangles as far as the Godávari river, when bad weather setting in I had to close work. I did not, however, close operations until the 12th of May, when both the difficulties of the work and the severity of the weather made it imperative.

In the course of the season's operations 1,240 square miles of country were traversed, 600 miles of which have been covered with 51 fresh triangles besides 136 triangles with two angles only observed, for the purpose of fixing the conspicuous objects on the coast. Seventy-four old stations were searched for, of which 56 were found, and *pakka* masonry stations were built over them with closing rectangular pillars of the usual dimensions. The searching for the marks entailed a great deal of patient labour, for those made on hill-tops are but a circle and dot engraved on the bare face of the rock, while those made on the sea shore were, with few exceptions only, pegs driven into the sand. Days had to be spent in scraping and washing rocks that were covered with earth and moss accumulated during the past 25 years until the mark could be discovered, but the search was prosecuted with so much diligence and care that all were found but six.

The beacons erected were 17 in number; besides these there are three others built by the Marine authorities at the minor seaport towns, and four light-houses, which make 24 points of reference in a coast line of 240 miles. The beacons were built of *pakka* brick masonry, obelisk-shaped, 15 to 24 feet in height, and 5 to 7 feet square at base. Great care was taken to select good sites for them, to ensure their being visible from a distance at sea, as well as to secure their permanency. Several were built on hill-tops or upon rocky ground, while those unavoidably built upon sand mounds have been provided with deeper foundations and broader bases, and the common cactus and screw-pine, which grow readily here, have been planted round them, to secure the sandy ground from wind action.

One of the chief difficulties I had to encounter during the prosecution of the work last field season was the recruiting of men for the native establishment. A heavy and constant emigration to foreign ports for service, especially to Moulmein and Rangoon, denudes the coast of labourers. Before the establishment of steam communication between this coast and Burma, they crossed the bay in country crafts only at the most favourable seasons of the year; but now a weekly mail steamer plies between the two coasts, and the stream of emigration is

continuous. Hence very few men could be got for service, and those entertained became dissatisfied with the pay and work and soon left me. Others were got at Chicacole, and they remained till the end of the season, but could not be persuaded to return for work next season without enhanced wages.

The country through which the triangulation was carried on is that bordering on the coast from Kovita Station Lat. 19° 2' Long. 84° 44' to the mouth of the Godávari Lat. 16° 42' Long. 82° 20' about 240 miles in a direct line and 5 in breadth, covering the ground of three different districts, *viz.*, Ganjam, Vizagapatam, and Godávari. The physical aspect of this country is very varied, while it is the most fertile and populous portion of the districts above named. From Kovita Station, where the operations of the season's work began, the coast line trends in a south-westerly direction, and as far as Bimlipatam the land is open, flat, and low-lying, and interspersed with isolated hills; while in the back ground westward is seen the chain of Ghauts which extend in a line parallel to the sea coast from the river Mahánadi in Orissa to the Godávari. From Bimlipatam to Polaram, 40 miles south of Vizagapatam, the coast assumes a bolder appearance, the hills approaching the margin of the sea shore forming remarkable head-lands and conspicuous landmarks, which serve as guides to navigators on this coast. The most notable among them may be mentioned the Quoine Rock, Pillar Rock, Dolphin's Nose, and Sugar-loaf Hill. From Polaram to Coringa the land is flat and very woody, and through the latter portion, between Cocanada and Coringa, the seaboard is fringed with a mangrove jungle covering a low lying marshy ground.

In the 240 miles of coast line surveyed, there are 10 seaports, which may be briefly described as follows:—

Báruva Lat. 18° 52' Long. 84° 38' is a small seaport town 10 miles south of Gopálpur. To the south and west of the town are large groves of cocoanut trees, and to the north is an open sandy plain. It has two columns for beacons, one painted white and the other black, 50 feet in height, and built on the sea beach about 450 feet from the high-water mark. Steamers and sailing vessels do not call at this port regularly, but only when they have cargo to take or land. It is an open roadstead, and landing and shipping cargo are attended with danger owing to the high surf. The principal exports are rice, cocoanut, and salt-fish.

Púndi, in Lat. 18° 41' Long. 84° 25', is a small port 16 miles from Báruva: this port has a considerable coasting trade, but the surf here is so high during the monsoon that communication with the shore is precarious. It is marked with an obelisk-shaped beacon 50 feet high, built on a small hill 19 feet above sea-level, on which stands also the Custom House flagstaff. Almost midway between this port and Báruva is a remarkable isolated conical hill called Rati, on the summit of which a beacon, obelisk-shaped, has been built and will be a good landmark to coasters plying between the two ports. The river on which the town is situated is deep, but there is a bar at the mouth of it which has about 10 to 12 feet of water over it at high spring-tide. Native craft often come in for repairs, and cargo-boats also load and discharge up the river instead of on the open beach.

Bawanapad is a small port in Lat. 18° 30' Long. 84° 21'. It is marked with a column 50 feet high, coloured white and black, built on the beach 816 feet from the high-water mark; to the north under a tope of trees is the Custom House, and to the south is the village which is a very insignificant one, and the inhabitants of which are principally fishermen. The trade of this port has been *nil* during the last two years, owing chiefly to the want of good roads.

Calingapatam Lat. 18° 21' Long. 84° 10' is one of the principal towns and the most southern port of the Ganjam district. It is situated on the mouth of the Vamsadhára river, 16 miles east-north-east of Chicacole. The characteristic feature of this port is the conspicuous head-land, generally known as Garrah Hills, but designated in the Survey records as Salibundam H. S., which is 5 miles from the sea and may be known by the two white pagodas on its slope with a single tree just above one; on the highest portion of it is the square platform with the rectangular closing pillar of the Survey of India. To the south of the town and at the extremity of a tongue of land called Calingapatam Point, Lat. 18° 16' Long. 84° 10', is the beacon light. The beacon is constructed of cut stones, obelisk-shaped, 60 feet in height, on the top of which the lantern is placed. A white fixed light is displayed here which is visible to about 8 miles at sea in clear weather, and is intended to warn vessels off the Satara Reef—a sunken patch of rocks which project from this point. The trade of this port declined during the past few years, but has lately revived in consequence of the mail steamers touching here. The principal trade is in rice, jaggery, tobacco, and other natural products of the country. The town has a deserted appearance, the ruins of large mosques which exist indicate a by-gone Mahomedan rule, while the deserted godowns and dilapidated bungalows intimate that the town was once the residence of European merchants and settlers.

Chicacole is a town of considerable importance in the Ganjam district, situated on the left bank of the river Nágávali, 16 miles from Calingapatam and about 5 miles from the sea. It is the head-quarters of the taluk and has a subordinate revenue and judicial establishment. For many years it was a military station, but is now the favourite resort of pensioners of the Madras army. The trading capacity of this town is small now, but at one time it was famous for the manufacture of muslins which rivalled the productions of Dacca and Arni. English manufactures have driven this commodity out of the market, since it is impossible for the weavers to produce a piece of muslin under R300 or R400, while the time needed to produce it is about a year.

Bimlipatam is one of the principal seaport towns of the Vizagapatam district in Lat. 17° 54' Long. 83° 29'. It is situated on the coast, about 18 miles north-east of Vizagapatam, and may easily be

recognised by a remarkable flat-topped hill, west of the town, on the side of which, as it gently slopes towards the beach and river, the town is built, affording a very picturesque view from the harbour. On the summit of the hill are the ruins of a bungalow, and a group of palmyra trees; and about 100 yards from the latter, on the northern brow of the hill, is the great Trigonometrical Survey mark made on a rock over which a masonry beacon, obelisk-shaped, has been built, which will be of eminent service to coasters making for the harbour. There is also on the south-east face of the hill, about half way up, a large white temple. Bimlipatam being the chief town of a taluk has a Subordinate Magistrate's Court, Telegraph and Post Offices, and the Madras Bank has a branch here. The river on which the town is situated is a very insignificant one and has besides a bar at its mouth which only admits of vessels up to 60 tons burden entering it, and that only at certain times of the year. The loading and discharging of cargo are done on the open beach. During the south-west monsoon the high surf makes communication with the shore very difficult. The port enjoys a considerable trade, and steamers and vessels of heavy tonnage call here at all times of the year. The export of rice and oil-seeds to France are greater here than at any other port on the coast.

About midway between Bimlipatam and Vizagapatam and about 5¼ miles north of Waltair is a remarkable peak called "Sugar-loaf Hill," locally known as Rasi Konda, on the summit of which is built an obelisk-shaped beacon 15 feet in height. This being white will render the peak more easily discernible from the sea, since, although a remarkable headland, it is obscured by high lands beyond when viewed from a distance.

Vizagapatam is the chief commercial town of the district in Lat. 17° 43′, Long. 83° 21′, and may be known by the bluff headland called Dolphin's Nose, on the summit of which stand a house and a small tower with a flagstaff in the centre. There is a house at the foot of the hill near the mouth of the river, and a cave said to extend many miles inland, but so infested with bats and snakes that no one has ventured to explore it. The town is situated on the northern bank of the Baramagetta river and extends 3 miles northward as far as Waltair, where the European residents, both military and civil, reside. The Settlement occupies an elevated spot about 230 feet above sea-level, and is remarkable for its salubrity.

The Baramagetta has a bar across its mouth, which is an impediment to vessels of more than 250 tons burden, and which has only 3½ feet at low-water neap-tide, with 7 feet high-water springs, rising, however, during the north-east monsoon to 10½ feet; but the depth of water opposite the Custom House wharf is about 20 to 27 feet, and here all the Masula boats load and discharge their cargo. It is, however, a favourite harbour for country craft, as they can lay up in mud docks during the south-west monsoons which prevail here with great violence. The port enjoys a considerable coasting trade by means both of country craft and the British India Steam Navigation Company's steamers, but little or no export trade with Europe, which has been taken up by Bimlipatam, where all the European merchants and agents now reside.

The town of Vizagapatam has long been famous for the manufacture of native cloths and ornamental articles made of buffalo horn, ivory, porcupine quills, sandalwood, and silver. Work-boxes, desks, chess-boards, and a variety of articles, both useful and ornamental, are turned out with great taste and in a style of workmanship equal to, if not surpassing, similar work in any other part of India.

Pudimerka is a small seaport in Lat. 17° 30′, Long. 82° 59′, about 6 miles south of Vizagapatam, and may be known by a remarkable rock called "Pillar Rock," which lies south of the village about ¾ of a mile from shore. This rock stands out in the open sea like a black column 10 to 15 feet in height in 5 fathoms of water and is connected with the shore by a ledge of rock which serves as a break-water during the south-west monsoons, so that vessels can load here, during that season, with facility. The trading capacity of this port, however, is very small and vessels seldom call.

Cocanada Lat. 16° 56′, Long. 82° 17′ is the principal seaport town of the district of Godávari and, next to Madras, the most important commercial city on the Coromandel coast. It is situated on the north bank of a river and on the opposite bank is the old Dutch town of Jagarnathpuram, which is connected with Cocanada by means of an iron bridge. It is the administrative head-quarters of the district and has a Magistrate's Court, Telegraph and Post Offices. The town owes its prosperity greatly to the excellent harbour it possesses, and to the canal which connects this river with the Godávari, by means of which the resources of the country are brought in for exportation to other ports. The anchorage is considered safe, with a soft bottom and good holding ground, and although it is about 3 or 4 miles from the mouth of the river, the bay is generally smooth at all times of the year, and communication with the shore is seldom interrupted. The shoals, however, at point Gordeware and Hope Island have of late years been gradually extending towards the north, and the anchorage has been in consequence shifted more to the north-east, so that the light-house, which was built in 1865 on the northern bank of the river, being now so far away, the signal no longer serves to guide vessels to the harbour: no light is therefore exhibited from this point now, but another has been erected at Vakalpudi, which is almost due west of the anchorage and about 4 or 6 miles north of the old light-house. Vakalpudi light-house is in Lat. 17° 1′, Long. 82° 20′. It is a white tower 81·7 feet in height from base to vane, and the light is a revolving one of the 4th order, flashing at intervals of two minutes. This port has improved very much during the past few years, and a very large outlay has been incurred in making two groins, one on either side of the mouth of the river, for the purpose of deepening the channel, and dredging machines are employed for clearing the bar continually, so that the channel should be kept open for navigation.

Coringa, in Lat. 16° 49′ Long. 82° 17′ at one time the most important seaport town on the coast where ship-building was extensively carried on, is now but a small and unimportant place. It is situated on the bank of the northern branch of the Godávari 8 miles south of Cocanada. Native craft still frequent the place, coming in for repairs during the south-west monsoon.

Between Calingapatam and Bimlipatam, about 15 miles from the latter, 5½ miles from the shore, and almost due east of the mouth of the Konada river Lat. 18° 0′ Long. 83° 46′ is situated the sunken reef called Santapili Rock. It is the most dangerous shoal on the Coromandel coast, all the more perilous since no indication of its existence is visible during fine weather. The sea does not break over it, nor is there any discoloration of water to warn mariners of its proximity. It has 7 feet of water over it and 8 to 10 fathoms all round, and there is a safe channel between it and the mainland about 4 miles wide. Santapili light-house, Lat. 18° 4′ Long. 83° 41′, built on the summit of a small hill in 1847 for the purpose of warning mariners off this dangerous shoal, is about 6 miles north-west of this rock, and is about 4 or 5 miles north-east of the village of Konada, and 150 feet above sea-level. The light is a white fixed one of the 4th order, and is visible at the distance of 14 miles at sea during fine weather. While the light affords a sufficient guide by night, the Santapili peak, which is a remarkable land mark known in the Survey records as Kandiwalsa H. S., nearly 1,800 feet above sea-level, affords a safe and sufficient guide by day.

Extract from Narrative Report of CAPTAIN J. R. HOBDAY, *Officiating Deputy Superintendent, in charge No. 4 Andaman Topographical Party,—Season 1884-85.*

Survey operations in the South Andaman Island were commenced on the 1st December 1884, and on the 6th of that month the tug steamer *Reclaimer*, which had been placed at our disposal by the Government of India, arrived in Port Blair towed by Her Majesty's Indian Marine Steamer *Tenasserim*. On the voyage from Bombay both vessels had encountered very bad weather, and the *Reclaimer* was much damaged in consequence.

Her repairs were immediately taken in hand, and I started on my first trip on the 11th December to Shoal Bay and the archipelago, together with Mr. Oldham of the Geological Survey and Mr. Ferrars of the Forest Department.

On my return, 24th December, I represented to Colonel Cadell, V.C., the Chief Commissioner, that I was unable to carry on single-handed my survey operations as well as the navigation of the *Reclaimer*, and suggested that a qualified officer of the Indian Marine should be placed in command for the better safety of that vessel. Mr. Fletcher was then appointed to take charge of the *Reclaimer*.

On the 4th January we started on our second trip, and all went on satisfactorily till the 14th, when, proceeding from the Andaman or Middle Strait to Port Meadows, the vessel struck on a rock not shown on the chart, about ¾ of a mile outside the above-mentioned harbour and about 25 miles up the coast north of Port Blair. The weather being calm we were enabled to land the convicts, police guard, klassies and Government property before dark, and a boat in charge of Mr. Ferrars was despatched to Port Blair for assistance. Unfortunately the station steamer *Kwangtung* was away at the time on a cruise with the Chief Commissioner, and the steam barge with lighters did not arrive at the scene of the occurrence till too late, for about 3 P.M., the following day, 15th January, the *Reclaimer* suddenly slipped off the rock and sank in about half an hour in 5 fathoms of water, the steam barge not arriving till about 10 A.M. of the 16th January. Messrs. Fletcher, Oldham, and I, together with about a dozen or so of the crew, remained on board till she sank.

After this misfortune the Chief Commissioner was good enough to order up the *Nancowry* from the Nicobars, and in this vessel, and the *Kwangtung* for a time, and then with the steam barge, the triangulation and ½ inch survey were carried on at intervals.

Life in a steam barge 50 or 60 feet in length, mixed up with engines, coals, stokers, convicts, savages, klassies, stores, &c., &c., has to be experienced to be thoroughly appreciated, and but for the excitement of cruising about in dangerous waters and landing through the surf, which, by-the-bye, is quite an art in itself, one's existence would be dull indeed.

The Andamanese we met were generally amicable. I made friends with one group, by introducing them to the game of "leap frog" over a theodolite stand; however, none of them succeeded in getting over; their attempts were highly ludicrous and appeared to amuse them as much as they did me, each failure being greeted with yells of derision by their comrades. A still more successful device was adopted, I believe, by one of the settlement officers some years ago, in order to win the affections of these aboriginal tribes, that of stripping *in puris naturalibus*, and dancing a break-down on the beach. Now-a-days an outlay of clay pipes, tobacco, rum, sugar, and rice will ensure their friendship, that is to say, so long as your commissariat can afford to supply them with these commodities. The same cannot, however, be said of the savages on the Little Andaman Island (the most densely populated of all), for they still remain openly hostile notwithstanding the friendly overtures that are made them annually, so I am doubtful whether we shall be able to land to do any surveying thereon next field season.

Not being a sailor myself I feel somewhat diffident in offering nautical information. My only excuse for broaching the subject is that possibly these few notes may prove of some small assistance to those who may some day be employed in the marine survey of these islands, and I trust, therefore, that all technical errors of expression will be forgiven.

There are two channels of communication by water dividing the Middle Andaman from

the South Andaman Island, one known as the Andaman or Middle Strait and the other as Homfray's Strait: there exists a chart of the former surveyed in 1795 by John Wales, the master of the *Ranger*, and although of so ancient a date I have no hesitation in pronouncing it the best specimen of marine survey charts of these islands that are now procurable; the soundings shown thereon, notwithstanding the time that has elapsed since the survey was accomplished, were found almost identical with those taken by us.

There is a bar at the eastern entrance with muddy bottom and about 1½ fathoms at low water, after which no soundings less than 3 fathoms will be encountered (that is to say, in the proper channel) until you emerge on the western coast of the islands, so that a vessel drawing, say, 9 feet of water would have no difficulty in steaming through provided she kept in the proper channel. Unfortunately John Wales in his sailing vessel found some difficulty in getting out to the westward, and after grounding several times on the coral patches east of Spike Island, eventually found a passage out by the south of that island. This turns out to be a very dangerous exit, and it now appears that what John Wales mistook for a bay to the northward is really a far more practicable passage out, east of Spike Island, but the channel is narrow, in the neighbourhood of the coral banks and requires buoying. Once past these dangers you arrive at one of the finest harbours in the Andamans, with a capacious anchorage in 10 to 12 fathoms of water. The exit north of Spike Island is narrow but very deep.

Homfray's Strait is not so practicable as the Middle Strait. I have only taken rowing boats through it, although I believe some of the settlement officers have gone through in a steam launch. The same bar exists at the western entrance, with rather less water than met with at the eastern entrance of the Middle Strait, and in both straits the flood tide runs from west to east as far as the bars on the eastern coast. The currents are strong, especially in Homfray's Strait. The courses recommended are shown in dotted lines on the published map.

Regarding the group of islands known as the "Archipelago," the eastern coasts are very dangerous, the reefs running out to great distances. In heavy weather shelter can be obtained in the channel named "Charka-Juru" by steering between the North Button and Outram Island and thence entering the strait from the westward. There are also good anchorages in the Kwangtung Straits, but one should enter, if possible, from the westward.

The method adopted for surveying the numerous creeks which run up into these islands was as follows:—

The distances were measured by long lead lines of 10 to 20 chains length, with corks affixed at chain intervals, and pieces of cloth to mark every 10 links, whilst the angular measurements were taken with a prismatic compass.

Two boats are necessary for this mode of procedure: in rowing up the creek small pieces of white cloth were attached to the overhanging branches of mangroves at suitable positions in the bends of the channel, the measurements being effected during the return journey down the creek, recorded in a field book, and plotted on the plane table. If possible, one should time one's work so as to go up and return with the tide, which is often very strong. The edges of all the creeks are bounded by mangroves, which generally extend for some distance inland, moreover, the water is very deep close to the banks so that it is impossible to work with a plane table.

The usual discomforts of ticks, leeches, and boils were experienced by most of us, but on the whole the health of the party was fairly good, attributable, I fancy, to the fact of December being a dry month. Now that the survey is advancing away from Port Blair the difficulties of procuring supplies are in proportion increased, a matter which calls for a special allowance to remunerate those who labour under peculiarly novel and trying circumstances in an equatorial climate.

Extract from the Narrative Report of MR. M. J. OGLE, *Surveyor, lately officiating in charge of the Assam and North-Eastern Frontier Survey,—Season 1884-85.*

To enter the Bor-Kampti country from Bishi, the last of the Singpho villages on the right bank of the Diyun, the river is crossed at that village over a strong rapid. There is a large flat *chur* on the opposite side through which the path runs, and passing through the small village of Pengaon, it continues along the bed of the river which is a wide shingle flat about one mile broad, intersected by small streams and dotted by small patches of forest and grass, the main channel of the Diyun keeping close under the low hills to the north. The path strikes the river again at the deserted village of Aidong, which is prettily situated on a patch of high ground. Here it again crosses over a rapid and then keeps along the right bank for about half a mile, ascends a steep slope about 200 feet, goes along a level bit and descends into the Dungan-Kha, a stream which one might call one continued rapid. The path lies more or less close along the left bank for some three miles, when it crosses the river, and the ascent to the Nchongbum is commenced. The ascent is very gradual and easy, long flat bits occurring in several places. The last descent into the Daphapani valley is pretty steep, but not of great length. Another route from Aidong lay along the Diyun, but 1½ miles from that place the river narrows to a gorge and is too arduous to be attempted by men, but it proved better than the Nchongbum route for laden elephants, the journey by the latter being made in two days and by the former in one day.

Early in February Colonel Woodthorpe, Major Macgregor, and Dr. Grant (being encamped in the Daphapani valley, where Mr. LaTouche and myself joined them) endeavoured to make the ascent of the Daphabum. They went up the Dapha river for about seven miles from camp,

at which point the river enters a gorge, the hills rising straight up from the water. No trace of a path exists in this dense tangled jungle, and it was impossible to continue along the river which here flows swift as an arrow, its bed blocked with immense boulders, so the attempt to make the ascent was abandoned. While camped here a subsidiary depôt was formed for storing supplies. Elephants could be used up to this point, either by the Nchongbum route or up the Diyun and thence coolies only were of use. After a sufficient quantity of supplies had been collected, the party started for Kumki *en route* to the Bor-Kampti country on the 3rd February. The crossing of the Daphapani near its junction with the Diyun is wide and the current swift, and in places up to a man's waist. The path kept along the bed of the Diyun over shingle and small rocks for about 12 miles when it became very bad indeed; one day's march in particular was so bad that not more than 3½ miles of ground was covered. The rest of the road into Kumki in places was pretty much the same as on the first day of leaving the Daphapani, and in some parts a good deal worse. Several streams coming down from the Wangleobum range had to be bridged to facilitate the movement of coolies, and the path where it crossed over spurs was improved and in several places hand rails were put up. Within five miles of Kumki the river was forded as many times. From this village, which is situated on an open flat valley, the path ran eastwards over a low hill at its head, and on the opposite side struck the Diyun again which here runs with a broad mild current and was at once crossed. A little above this the valley widely opens out and the stream itself is broken up into a network of channels, separated by banks of stones and thick grass. For about five miles the route lay almost as much in as out of the water, when it again leaves the river bed and rises up to a level grassy plateau about 250 feet above the river. It then goes up and down hills for about six miles when the river is again met, and at this point runs between the hills; it follows the river over huge rocks and boulders, crosses the Merit-Kha, which is almost as large as the Diyun itself, near its junction with it, and continuing along the left bank of the latter, crosses it, and the ascent of the spurs thrown off the watershed that divides the Brahmaputra and Irrawaddy is commenced. After ascending and descending a few of these and crossing a few rivulets the Diyun is again struck, which here is a very small stream, and continuing along the bed for a short distance the path crosses over a very easy pass called Chaukam, at an altitude of 8,300 feet. This and another which crosses the Patkai and keeps along the Turong river and eventually comes out at Kumki are the only tracks from Bishi into the Bor-Kampti country which the survey party traversed. Neither of them certainly is to be recommended as a highway into China, both on account of the absence of villages and the badness of the paths. Moreover, owing to the pass being under snow during a part of the year, and the heavy rainfall at an early time of the year which makes the route dangerous and impassable, it can only be used for a little over four months out of the twelve. The onward track from the Chaukam Pass and the Turong one has probably been described by Colonel Woodthorpe and Major Macgregor.

The country under report contains only two villages, *viz.*, Kumki and Timolia. For the rest it is an uninhabited forest-clad hilly tract, the height of the hills ranging from 1,500 to 15,000 feet. To the north of the Diyun the hills rise suddenly and precipitously attaining at Jaitu an elevation of 10,864 feet, forest covering the hills almost to the very top. The summit is bald, rugged, and broken. The range extending eastwards rises and falls till the culminating point Daphabum 15,010 feet is attained, towering sharp and pointed high above all the surrounding peaks and covered with snow. The snows extend right round the head of the Dapha valley and continue round to the head of the Turong valley with just a few breaks between, then turning west begin to disappear near Phulobum when the hills drop from the general level of 12,000 feet. To the south of the Diyun is a confused mass of dark forest-clad hills, the highest point Laphabum rising to nearly 8,500 feet. Formerly there were several villages between Daphapani and Kumki, but now they are deserted. Kumki, called Khamong by Wilcox, is situated on the left bank of the Diyun, which river at this place flows immediately under the hills along the northern side. From the left bank southwards the country is an open flat, being about one mile broad and two miles long. It is swampy and covered with long grass except a few acres on which rice and small patches of opium are cultivated. Kumki is split up into two villages, one called Timla on the north-west portion of the valley close under the hills, containing 18 houses, and Bumgaon about the middle of it with nine houses. This valley about a century ago was peopled by a tribe called Mattacks who were driven out of the country by the Singphos. The hill sides have traces of having been extensively jumed by them.

The principal rivers of the country are the Turong-Kong to the south and the Diyun to the north; the principal feeders of the former are the Loglai and the Kingan-Kha, those of the latter are the Daphapani and Namphuk. The Diyun from its source flows almost due west. After it leaves the hills under Tinkong plateau, or where it is joined by the Merit-Kha, its valley widely opens out and gradually narrows. It continues this direction for four miles, then takes a sharp bend to the south, where it is hemmed in between low ranges, and opening out again takes another sharp turn a little to the north of west. The bed is narrow in places, but for the most part is wide and open, the river breaking off into several channels, forming fine long deep pools from some distance above its junction with the Dapha till it fairly emerges into the plains at Wakidgaon. The Daphapani rises in the Phungan range of hills and also flows almost due west till it is joined by the Inke when it takes a sharp bend nearly due south, a little below which the valley opens out into a flat plain covered with ulu (pampas) grass and strewed with boulders. The length of this valley from north to south is about six miles and its greatest width a little over a mile.

The valley is almost triangular in shape, its base being formed by the Diyun on the south. The Dapha, when it emerges into this open valley, breaks into several channels, some of which join again lower down, forming islands, and others flow into the Diyun, but the main stream runs along the base of a precipitous cliff some 500 feet high. At both ends of the valley this cliff gradually slopes off and forms the western edge of a series of plateaux or terraces rising one above the other; the first terrace is about half a mile broad, presenting light tree jungle interspersed with tall grass and at the foot of the second step a long grassy swamp. The second plateau is not more than 300 yards wide and the jungle is much denser, the third and last is about a mile broad and covered with bamboos.

The season under report was remarkable for the extraordinary amount of rain which fell in those regions. The first shower was on Christmas Eve. On referring to my diary I find that from the 1st January to the 30th April, that is 120 days, it rained in January 5 days, February 12, March 16, and April 20 days, making a total of 63 days of wet weather. From the end of March it was positively dangerous to be on the opposite side of the river to that of the depôt, owing to the sudden and high rises of these mountain torrents. On the return of the detachment with me from the Chaukam Pass it rained so heavily one night, 16th March, that the Diyun near its junction with the Merit-Kha was rendered unfordable, and we had to cut our way through thick grass, till the waters subsided, which fortunately they did in a few hours, the rain having ceased. In several places on this journey to Kumki, we had to cut through forest to avoid rapids which were easily crossed a week before, but which were now running swift and deep. On the return from Kumki to Daphapani we had a week's lovely weather, after which it became wet again. From this place I went with a party to Langkubum. The Diyun had to be crossed, and it was easily fordable about the middle of March; we crossed over on the 25th on elephants, the water just touching their bellies. We began to return from the hill on the 1st April, a fine clear day; there was almost incessant rain during the five previous days. We camped that night about half way between Langkubum and the river, and the next morning early I sent two sepoys in advance to order the elephants over. I had intended that the sepoys should cross over a bridge we had made over the Daphapani—a little above its junction with the Diyun, the latter river being easier to cross higher up than where we had crossed. The sepoys found that the heavy rain had swept the bridge away, not a vestige of it being left, so leaving their arms and accoutrements in charge of a khalassi who accompanied them, they swam across, a very daring and plucky act (which has been brought to the notice of their Commandant and the Inspector General of Police), as the river was flowing with rather a strong current, and there was a terribly swift rapid 600 yards below their starting point. They narrowly escaped being swept down this rapid, landing just at its head; had they shot it, all would have been up with them, as they would inevitably have been dashed to pieces. It commenced to rain about 9 o'clock, and by the time we got down to the Diyun it was pouring in torrents. The elephants arrived about noon; the river was fast rising, but all were across by 3 P.M., not a bit too soon, as at the last trip the water had reached the pad and another trip would have been impossible; the river continued in high flood for several days. On another occasion a khalassi had been sent with some coolies to clear a point; it rained the whole time they were on the hill and not much work could be got out of them, so they were recalled. They had to cross the Inke, a stream running down from Jaitu. When they got near this stream it came on to rain hard, but all got across except the khalassi and another, who remained behind with a sick coolie, and when they reached the stream it was unfordable, and the unfortunate men were obliged to wait on the other side for two days, wet, cold and miserable and without food. After cessation of rain for a few continuous hours they were able to bridge the torrent, but with great difficulty, and they crossed over. Near the Daphapani an elephant narrowly escaped being lost. The keepers were taking her down to head-quarters camp by the river route. She crossed one or two rapids, and at last got to a very bad one which she refused to cross. They then tried to retrace their steps, but the animal becoming frightened at the roar of the waters, would not attempt to re-cross the rapids she had already passed. They remained on a *chur* and we made several attempts to get her off, but without success. At last when the river had fallen a bit, we succeeded in getting another elephant over, which drove her off the island. They were nine days on the island with very little food and no fire. The mahout was missing. He told his assistant to remain with the elephant while he tried to find a way down the river. What became of the unfortunate man it is impossible to say; he probably died of starvation or was killed by wild beasts.

This was a very trying and anxious time, as we did not know what was the fate of Colonel Woodthorpe and his detachment. We retraced our steps to Ndong keeping along the right bank of the river. On our journey out we had crossed the Diyun twice from Bishi to the Daphapani, but it could not be done now. The route we followed on our return is not used otherwise than on exceptional occasions; since *tilas* have to be crossed, and in ascending and descending these, ladders had to be made some 120 to 150 feet high, the sides of these *tilas* being perpendicular cliffs: in parts the road is fair, in others very bad.

We arrived at Ndong on the 18th April, and on the 19th a havildar with two sepoys came in with letters from Colonel Woodthorpe (who was some 13 miles away across the Namphuk with Major Macgregor and establishments) asking for supplies to be sent out. They had eaten up their last ounce of rice that morning having been on three-quarter rations at starting from Kumki, which was reduced to half, and eventually to one-quarter, and on this last quantity they had to subsist for two days. I should mention that Colonel Woodthorpe had taken out a Berthon collapsible boat, which proved of the greatest possible use particularly on this occasion. Immediately on receipt of his letter supplies

were got ready and Dr. Grant kindly consented to go with the coolies. There was a dug-out at the ford but on the opposite side of the river, which was much swollen, so much so that some of the elephants could not cross at the place where the coolies waded when we first went there. Dr. Grant went across in the Berthon boat taking a Singpho with him and proceeded to the village, to get men to work the dug-out. One man came, but we were obliged to use our own sepoys, so between the country and Berthon boats the supplies and men were across by night-fall. Dr. Grant continued his journey till midnight and stopped at the village of Namphai. Meanwhile Colonel Woodthorpe was crossing his men over the Namphuk on rafts made of bamboos and plantain stalks. On the 20th the two parties met at Shikao, and for the first time after several days the Bor-Kampti detachment had a good meal. We fortunately succeeded in getting another dug-out, and by lashing the two together enabled the men to get over in comparative safety. They were all at Ndong by the 23rd, and it was pitiable to see the starved pinched condition they were in. Colonel Woodthorpe's return journey from the Bor-Kampti country to Kumki was more fraught with danger than ours. I quote from one of his letters: "I wish we could have carried our work right up to Manchi, but if we had, we should not have got back again, our bones would probably now have been whitening the banks of the Diyun somewhere. I did not bring the route right up from Mungang as I hoped, from the knowledge I had acquired of the valley, to have been able to fix myself along the road; the weather was, however, so wet and hazy that I could not manage that and so took up the route." Their last crossing of the Diyun before coming into Kumki was effected by sepoys holding branches of trees which the coolies used as hand rails. While crossing, heavy rain was pouring on the hills around, and had they arrived there half an hour later they would probably never have got across, the river keeping a high level for several days, and the whole country being now so saturated with water the floods took a longer time to go down than at the commencement of the rainy weather.

The first detachment began leaving the country with the ammunition and regimental tents and stores on the 20th April, the evacuation having to be done in batches, owing to the paucity of boats available from Sadiya. All arrived at that station by the 4th May and at Dibrugarh on the 6th. Here we parted company with Major Macgregor and the splendid body of men he commanded who, through a most trying, protracted and arduous season, worked most cheerfully, putting their hands to everything from making roads and bridging streams, to working rafts and helping coolies over difficult rapids, and sharing with them their own rations when they were in danger of starvation themselves.

This being the last Narrative Report of No. 6 Topographical Party, and since I have been associated with it from almost its very commencement, and as it has fallen to my lot to write it, a brief retrospect of the party's operations and history may not be out of place.

In July 1863 the Government of Bengal made repeated and urgent requisitions for the survey of the Khasia, Garo, and North Cachar Hills, and by December of the same year assistants were transferred from other parties, and the organizing of the Native Establishment, collecting data and instruments, purchasing camp equipage and all the requirements of a party were perfected by Mr. N. Belletty on whom this duty devolved, the charge of the party being entrusted to Captain, now Lieutenant-Colonel, H. H. Godwin-Austen, who in September 1863 was in Kashmir. While on his way down to Dehra-Dun to receive instructions from the Surveyor General, Lieutenant-Colonel Godwin-Austen received orders direct from the Foreign Office to accompany the British Mission into Bhutan as Surveyor and Assistant to the Political Agent. Notwithstanding this, the party left the Presidency in January 1864, and was placed in temporary charge of Mr. J. O. Nicolson. Shortly after the return of Lieutenant-Colonel Godwin-Austen from the Bhutan Mission, that is in October 1864, he was directed by the Military Department to accompany the Dooar Field Force as Surveyor, in consequence of which the party being without a competent officer, the Surveyor General recommended that Lieutenant, now Major, R. V. Riddell, R.E., should be appointed to officiate for Lieutenant-Colonel H. H. Godwin-Austen. This arrangement having been sanctioned, Lieutenant Riddell joined and took over charge of the party at Cherra-Poonjee in November 1864, and this charge he held till October 1856, when he was relieved by Lieutenant-Colonel H. H Godwin-Austen after the termination of the Bhutan War.

From the time the party broke ground in these hills up to 1867, it was employed upon 1″ scale survey. After that year as the survey extended into country which was getting more and more densely forest clad and sparsely populated, the scale of survey was changed to the ½″. By the end of 1868-69 all the Khasia hills and North Cachar hills were surveyed, and the following season the party broke ground on the southern outer ranges of the Garo Hills, it being considered unadvisable at this time to push the work further east into the jurisdiction of the Political Agent of the Naga Hills.

Owing to financial exigencies, at the close of the field season, the abolition of the party was ordered, and it was in consequence brought down from Cherra-Poonjee to Calcutta, Lieutenant-Colonel Godwin-Austen having proceeded on furlough. But through that officer's representations the Government were induced to consent to the retention of the party, and a portion of it was engaged the next season in surveying the outer ranges of the Garo Hills and two of its members deputed to the Naga Hills for the laying down of the boundary between that district and Manipur, a step which was considered very necessary by the Political Agents of those two States. Later in the season the Judicial Commissioner of Chittagong arrived to arbitrate a portion which was disputed by the Manipuris. Mr. Belletty held temporary charge till relieved by Lieutenant-Colonel A. B. Melville, but that officer dying shortly after his arrival at Maimansingh, the charge again devolved upon Mr. Belletty who at the

close of the field season was again relieved by Captain, now Lieutenant-Colonel, W. Badgley. The party recessed at Dacca.

Owing to constant raids made by Lushais into the Cachar and Sylhet districts, the Government determined upon despatching two columns into their hills in the cold weather of 1871-72 for the purpose of punishing them and for the release of an European girl, the daughter of a tea-planter, whom they had carried off captive. Advantage was taken of this military demonstration of sending survey parties to accompany each column, and No. 6 party was attached to the left column under Brigadier-General Boucher, which entered the hills from Cachar. The party was strengthened by the appointment of Lieutenants, now Colonels, R. G. Woodthorpe, R.E., and E. P. Leach, R.E., V.C. This party was again divided into three detachments operating in different parts of the country, one under Captain Badgley, another under Lieutenant Leach, and the third under myself. The scale of survey was 1 inch = 4 miles, and a very large area was secured. At the end of the expedition the party returned to Shillong, and this station has been its recess quarters ever since till the present year.

After Captain Butler had been appointed Political Agent of the Naga Hills, he represented strongly to the Government the necessity of pushing on the survey into the country inhabited by the various wild tribes in and around his district, and to his energy, perseverance and firmness, combined with kindness and tact, is due to a great extent the success which attended these operations—operations which were fraught with no little risk and danger.

Season 1872-73 found the party working in three detachments. Lieutenant-Colonel Godwin-Austen, who had returned from furlough, had charge of the one which entered the Naga and Manipur hills with Captain Butler and Dr. Brown as Political Agents of those two districts, respectively; another was under Captain Badgley with Mr. Power, C.S., as Political Agent, surveying uninhabited portions of the Lushai hills, and the third under Lieutenant Woodthorpe with Captain Williamson as Political Agent. This last-mentioned survey was taken up through Captain Williamson's urgent representations of the policy of bringing the Garo tribe under entire British control, a policy that was approved of and recommended, and sanction was accorded by the Government of India to sending an expedition into the country to carry out this work. The Garo and Lushai hills were surveyed on the $\frac{1}{4}$ inch scale and the Naga and Manipur hills partly on the $\frac{1}{4}$ and $\frac{1}{2}$ inch scales. The survey of the Garo hills was completed and a very large area secured by the whole party.

The survey continued its labours in Manipur and among the several Naga tribes inhabiting the hills south of the Brahmaputra, when in 1874-75 a military expedition under Brigadier-General Stafford was sent into the Daphla hills to punish the tribes for their constant raids into British territory. Advantage was again taken to send surveyors with the force. This season also the party was divided into three detachments. The Daphla one in charge of Lieutenant-Colonel Godwin-Austen, and the other two still extending operations in the Naga hills, one under Captain Badgley having Lieutenant Holcombe as Political Officer, and the other under Lieutenant Woodthorpe with Captain Butler as Political Officer. The detachment under Captain Badgley was treacherously attacked by Nagas, several hundreds of whom were imprudently allowed into the camp, and in the space of a few minutes out of a total of 197 souls 80 were killed on the spot, including the Political Officer, and 51 wounded, including Captain Badgley. This officer, though badly wounded in four places, collected the remnant of his men together and brought them down to Dibrugarh. Fortunately about this time the objects for which the Daphla expedition was undertaken were attained and troops, transport and commissariat stores were available at once. A punitive expedition under Colonel Nuthall was forthwith despatched into the country. Soon after the catastrophe Captain Butler was ordered to join Colonel Nuthall as Political Officer, and Lieutenant Woodthorpe's Survey detachment was also desired to accompany him. The work of punishing the treacherous tribes and the prosecution of the survey was well and efficiently done. It was unfortunate though that the Daphla detachment was not permitted to continue its operations as earnestly solicited by Lieutenant-Colonel Godwin-Austen; a good opportunity of extending our knowledge of the Frontier further north was altogether lost. The Daphla hills survey was prosecuted both on the $\frac{1}{4}$ and $\frac{1}{2}$ inch scales and the work in the Naga hills on the $\frac{1}{4}$ inch scale. This was the last season in which Lieutenant-Colonel Godwin-Austen held charge, he having retired from the service the next year. Captain Badgley then held charge.

In 1875-76 the party was divided into two detachments, one under Captain Badgley which had taken up the survey of the Garo-Maimansingh boundary and the Khasia-Kamrup boundary on the scale of 2 inches to a mile, and the other under Lieutenant Woodthorpe in the Naga hills, Captain Butler being again the Political Officer. Unfortunately at the outset of operations Captain Butler was wounded in an ambuscade by a spear which struck him in the shoulder and entered his lung; he died a week after and Lieutenant Woodthorpe was appointed in addition to his own duties to the Chief Political charge of the expedition, Mr. Hinde of the Assam Commission being made his assistant. This season saw the whole of the Naga hills completed up to our outer line and up to its north-eastern boundary, the extreme eastern portion having been previously surveyed by a party under Captain Samuells accompanied by Lieutenant Holcombe as Political Officer.

During the next two seasons, exploration surveys, to the east of Sadiya into the country inhabited by Singphos and Kamptis and north of the Brahmaputra into the hills inhabited by Miris and Mishmis, were conducted by one party under Lieutenant Woodthorpe, while another under Captain Badgley continued its labours on the aforementioned boundaries. Major Badgley in 1878-79 broke ground on the southern boundary of Sylhet district among the low *tilas* which had been left unsurveyed by the Revenue Branch. This survey was

carried on on the scale of two inches to the mile till 1882-83. During a part of season 1881-82, Major Badgley and myself were employed in laying down a portion of disputed boundary between Burma and Manipur; after completing the boundary Major Badgley went on furlough and I continued the work northwards among the Tangkul-Naga tribes inhabiting the Manipur hills and connected the survey on to where it left off in seasons 1872-73-74. Lieutenant Woodthorpe then assumed charge. In 1880 the survey of Shillong station was taken up on the scale of 24 inches to the mile and was quite finished in 1883. The work was carried on during the recess. At the close of this recess season, the party was greatly reduced, the members being transferred to other parties and only two assistants and two sub-surveyors retained.

In season 1883-84 a military expedition was sent into the Akha hills to recover captives and guns which had been carried off by the Akhas. Lieutenant-Colonel Woodthorpe's survey party accompanied it, and immediately after the rendition of the captives and guns, the country was evacuated, and the party entered the Daphla hills, greatly through the help of Mr. Penny, a tea-planter, who was on friendly terms with that tribe, and had entered their hills before by invite. This diversion enabled the survey to be connected on to the work where it had been left off in season 1874-75. But another good opportunity was also lost of extending our knowledge to the north by our not being permitted to proceed into the hills beyond, with a portion of the force that was in the country.

This last season saw the party working in the Singpho hills up the Dihing river and in the Bor-Kampti country, and it can compare with almost any other for the inconveniences and hardships endured by the members composing it.

Thus after an existence of 22 years the labours of the North-East Frontier Topographical Survey extending over hill tracts, large portions of which are totally uninhabited, and others densely populated by various savage tribes, who are at constant feud with one another, and view with suspicion and distrust any foreigner entering their hills, and with whom we had frequently come to open hostilities, have been brought to a sudden and abrupt close.

Extract from the Report of BREVET-COLONEL R. G. WOODTHORPE, R.E., *in charge Assam and North-East Frontier Party,—Season 1884-85.*

To Major Macgregor, who commanded my escort, my best thanks are due for his excellent arrangements for the safety of the camp and for the very great assistance he rendered in constructing roads, bridges, &c., and in collecting information as to routes, &c. I owe it to his exertions in this way that I was able with him to make the excursion into the Bor Kampti country and round by the Turong and Loglai valleys.

Doctor D. St. J. Grant, attached to the party, did excellent service in looking after the health and welfare of all, and in assisting the sick and weakly on the march, occasionally carrying them across swollen streams himself.

Mr. T. H. D. LaTouche, of the Geological Survey, also rendered similar assistance.

Of the conduct of the Sepoys and Frontier Police forming my escort and of the services rendered by them I cannot speak too highly, and I have had much pleasure in bringing them to the favourable notice of their respective Commanding Officers, of the General Commanding the District, and the Inspector General of Police.

Narrative Account of Exploration from Kúmki (on the Diyun River) to Padao (Bor Kampti) by MAJOR C. R. MACGREGOR, *44th A. L. I., commanding the escort attached to the Assam and North-East Frontier Party,—Season 1884-85.*

On the 8th March 1885, having got up some supplies from our depôt on the Dapha River, and having, with difficulty, secured the services of a Singpho as guide, we turned our faces eastward again, leaving a small guard to look after our depôt and sick coolies at Kúmki which I may mention is in North Latitude 27°-17′-10″, and East Longitude 96°-56′-40″ at an altitude above sea level of 3,600′ and distant from Sadiya 125 miles. Kúmki, or Khamong (slave country)—it is known by both names—consists of a triangular-shaped valley about 2 miles in length by 1 in width on the left bank of the Diyun river. There are, in this valley, two Singpho villages, one, the largest, situated at the south-west end of the base of the triangle and containing eighteen houses, is called Tingsá,* and the other, containing nine houses, is called Bamjan* and is situated at the apex of the triangle; the houses were large and well-built; one at Tingsá measured 116 feet in length. The little valley of Kúmki was formerly the abode of a race of people called Mattaks, who came from the south, probably from the borders of the Nongyong lake; the Kamptis and Singphos had either "improved off" or enslaved this, by all accounts, very inoffensive race, and had taken possession of the country. On leaving Kúmki our first march was one of nearly 7 miles; passing through the village of Bamjan we ascended a low hill, and descending, dropped down into the Diyun river, constantly wading up the bed of the river. We finally camped near a stream called the Shin Kha (Kha is Singpho for a river); the altitude of our camp was 3,900 feet. The next day we

* These names have been entered as Timla and Bumgaon on our maps. I believe both are correct.—M. O.

continued up the Diyun, the country becoming more open. At 3½ miles from our camp on the Shin Kha, we came on to plateaux on the left bank, and camped on the eastern end of the upper one. Our guide allowed me to take the few sepoys who composed the advance guard, and the coolies, some distance up the river, and then sent a message saying it was not the way, so back we had to tramp, and our progress through heavy jungle on the river's edge was not accelerated by a raging fire through which we had to pass (the fire originated accidentally, I believe, owing to the carelessness of one of the Singphos of our party). Thanks to the strenuous exertions of Ogle and his khalassis, the fire was partially extinguished and no harm was done luckily. The Mungongung plateau was a charming piece of level ground covered with short "*Oolu*" grass; in the centre there was a wood, and after having made all arrangements for our camp, Woodthorpe and I directed our steps to the wood, in the hope of replenishing our larder with a deer, and we were not disappointed. One of our Gurkhas, an excellent and most successful shikari, had gone out in another direction with the same object (*i.e.*, a deer) in view, and he also fulfilled his mission and added an enormous Sámber to the general stock, so that night the whole camp, coolies included, were able to indulge in a good square meal. In our wanderings over the plain we came across a quantity of sweet-smelling violets, and flushed some button quail. The plateau, which was said to have been inhabited by the Mattaks before the Singphos dispersed them, was 4,200 feet above sea level. Our Singpho guides here began to give us trouble, and pretended not to have understood that we wished to go on beyond this point, and intimated their intention of returning to Kúmki; after some palaver, and one of us having given his gun as an earnest of the reward which we had promised on our return, the guides consented to go on. We were much amused to notice that the guide ("The Image") did not take the gun with him, but sent a slave back with it to deposit it with his "Lares and Penates" at Kúmki. On asking the guide why he did this, he replied "Who knows what may happen to your party; *my* reward will, at any rate, be safe," and so the breech-loader vanished from the scene. On our return we redeemed it by giving in its stead a D. B. M. L., which was an arrangement satisfactory to both parties. Another Singpho, young Bishi Gam, who up to this had behaved very well, also demanded a gun; but he was told to go to Kúmki if he liked; however he preferred to accompany us. Soon after leaving the plateau a track was pointed out to us which, the guide said, led to the Hukong valley. We were informed that this track was used by the Singphos of Kúmki and by the Bor Kamptis when they wished to visit Hukong. Passing a Kampti halting place called Imbong Kua, at a height of 5,400 feet, we then descended 700 feet and struck the Diyun again, which was here 20 yards wide with an average depth of 2½ feet. Half a mile higher up we came on a river called the Merit Kha; it joined the Diyun on the left bank, flowing from a direction a little to the east of south. The Merit was very nearly the same size as the Diyun, and at first it was difficult to tell which was which. However our guide, jumping from rock to rock like a chamois, called out "this is the way;" so it was, but it was an uncommonly damp one. After getting a ducking in the river we kept along the left bank of the Diyun for about half a mile then crossed to the right bank near an island and camped. On this march some Kunnungs returning to Mánchi came with us part of the way, and said that they wished to go with us all the way, owing to their fear of the robber Singphos; but they (the Kunnungs) disappeared during the afternoon; perhaps they were not quite sure what kind of company *we* should prove! The next day we crossed a hill 7,300 feet and descended to the Lugadiot river, on the right bank of which was an old Kampti camping ground; this stream was conspicuous for some enormously tall nettles which grew on the left bank. Of course our guides stopped and swore that there was no more water to be found for miles; our leader however was not to be baulked in his intention of getting on as far as possible, and he found some water nearly a mile farther on where we camped at an elevation of 7,500 feet; there was no level ground, so we had to scrape out little holes to lie in and make the best of it. The night was a bitterly cold one. Some of our coolies broke down on this march, and one was not able to carry himself, much less his load; so Messrs. Ogle, Grant and La Touche carried the sick coolie by turns, and I must mention that this was not the only occasion that coolies were carried by the Europeans of the party, our young doctor especially being always well to the fore in helping to get sick men along. On the 12th, a two-mile trudge brought us to the head of the Diyun river. *En route* we crossed a stream called the Sámat Kha, and passed a huge detached rock, round which were the remains of an old camp called Lung-kung-dung Uprá; this walk was an excessively wet one. One felt, whilst tramping through the damp rank jungle, all sodden under foot, a great feeling of depression, and almost imagined that one's identity was being gradually lost, and that one would soon be merged into the mass of decaying vegetation which existed above, below, and around us. After passing the old Kampti camping ground near the rock, we again struck the Diyun river which was only a few feet in width. Continuing up the eastern branch of the Diyun, which bifurcated at this place, we came suddenly on an old Kampti and his son; the old man was very weak and ill with dysentery, and could not proceed, so he had sent on some men for food and help. One of our Singphos, Bishi Gam, took the old Kampti on his back to carry him up and over the Pass; but the poor man was too far gone and died on the road. We afterwards met the men he had sent for succour; they were hurrying back to assist the old man with food, &c. At the little stream where we found the dying Kampti, my aneroid read 7,100 feet, and it was from this place that the ascent of the Pass began; a comparatively easy climb of 1,200 feet brought us to the summit, up to which there was a considerable quantity of snow lying about in patches; it was hard work for the coolies wading through the snow and slush in the ravines where it lay collected and melting. Some of us tried our hands at snow-balling, and it rejoiced us to think that we were really out of Assam at last. An Assamese boy with me, whom I

had initiated into the art of snow-balling, announced his intention of filling a bottle with snow on his return, and taking it to Dibrugarh to show his friends in the Regiment. All, or nearly all, the snow having melted when we returned, the boy filled his bottle with hailstones, and after a few days of course found to his disgust that he had only a little dirty water in his bottle. That night we camped at a place called Galút. Woodthorpe and I stayed up far into the night making our preparations for our "new departure" on the morrow. When we were at Bai Búm* near Kúmki, we had made up our minds to visit the Bor Kamptis and the western branch of the Irrawaddy, and also to return into Assam, *viâ* the Turong river crossing the Patkai range near the Nongyong lake. Our guide, the Kúmki Singpho, at first demurred about going; but it was only, I expect, to see if anything more could be got out of us, and generally "se faire valoir," a principle that our guide and interpreter usually acted upon. Next morning, the 13th, we bade good-bye to the rest of our party, and taking with us a Havildar and two men of the 44th and a Gurkha of the Frontier Police, started off. We reduced our baggage to the lowest amount taking with us a khalassi's little tent to sleep in, a couple of large waterproof sheets for our escort and servants, and a little medicine and tinned provisions. As we all were short of rice, we only took enough to last us into the Kampti country, where we hoped to replenish our bags. Passing *en route* an old camp called Kúdtohok we camped at a place called Mokoshát (height 7,500 feet) and all night long it *did* rain! Old Deori, our interpreter, said the downpour was owing to our party burning bamboos which exploded, being filled with water, and he was continually calling out "don't make a noise or the Deo will send more rain;" the idea that noise brings rain is however not restricted to the Kamptis; Frank Hatton mentions that the same idea obtains among the Dyáks in North Borneo and in civilized countries cannon have been fired with the hope that the concussion would bring down rain after a prolonged dry season. On the 14th we waited for the rain to cease; but as it did not we commenced to climb the Mokoshát Hill; having attained a height of nearly 9,000 feet we descended. There was some snow lying about in patches on the top and on the slopes. From this hill we were informed that the Bor Kampti villages on the Námkiu river, and the valley of the Brahmaputra (which river the Kamptis and Singphos called "Tálau") could but be seen. I rather doubt the view of the latter being obtained. It was so stormy the whole day—hail, sleet and incessant rain—that unfortunately we got no view whatever, and it was the same on our return. Owing to the intense cold and the driving hail and sleet, which caused the track, which, with difficulty, we made out from the "blazing" of former travellers, to be very slippery, this was a severe march, and our Singpho guide (the Image) ensconced himself in a hollow tree and refused to budge; the man was exhausted and done up and so were the coolies. So after hunting in vain for some water we were obliged to camp without it, as darkness was coming on. Tired and hungry as we were (we had eaten nothing all day), and with no prospect of dinner, owing to want of water, we both could not refrain from laughter at the comical appearance that our guide presented. As he sat cross-legged in his hollow tree, with a fixed and vacant look on his stolid countenance, he reminded me of a picture I have seen somewhere of the God "Saiambu," the "self-existent and self-complacent one." Deori, too, though he said he would walk on all night, soon subsided beside the Singpho, and they made a charming pair of "Babes in the wood." We issued a tot of rum out to all our party, and having in vain, owing to the damp and rotten state of the wood, tried to light fires, turned into our little tent, which was as wet inside as out. Next morning we came across water not a mile off, and continuing on our way down to the Phungma river we halted on the left bank, and all of us cooked and ate by the river side. It was not a pleasant tramp down the Phungma (which was at this place, 4,800 feet above sea level, hollow-tree camp being 7,500 feet); the torrent had been so much increased by the heavy rain that the coolies with difficulty kept their footing, and we had often to help them along. We passed a small natural cave in the side of the rock on the right bank, close to a very narrow defile not a yard in width, where the river was confined between two hard rocks, rushing between them with immense force and in leaps and bounds, like water being poured out of a vessel reversed with a narrow neck; below this place several coolies lost their footing and rolled over in the torrent, luckily doing no harm to themselves, but wetting the few articles of clothing and food we had managed to keep dry up to this! That night we camped in a place the Singphos called Wrágá (derived, I think, from the Singpho, Wra, bamboo, and and gá, earth, place, abode); there were quantities of bamboos which came in very useful, especially for a tent-pole, as a coolie had unfortunately mistaken our pole for a bit of fire-wood when we fed by the river in the morning and had cut it up. Wrágá (4,900 feet) was a vile camping ground, the ground being damp and covered with rank vegetation, and heavy incessant rain prevented us from getting a little dinner cooked till late at night. On our return we avoided this place. During the night the rain came down in torrents and one imagined oneself in Cherrapoonjee; the crashing of thunder and the vivid flashes of lightning did not improve our night's rest. *Apropos* of thunder, the Singphos have rather a poetical way of expressing it—for "it thunders," they say "Mou Sigádé," the cloud is calling out. Our march the next day, about 7 miles, took us to the site of an old Singpho village called Langá; *en route* we crossed the Phungma river, where the stream bifurcates. Our friend "the Image" remained at the river; but we pushed on in search of a better camping ground, which we found about two miles further on at Langá. Next morning we had to go back and carry up our guide, and

* Biaobum in our maps, which I believe to be correct.—M. O.

he was carried all the way to the end of the journey; the man was really ill, so we fed him with beef-tea, and rum, and took every care of him, as setting aside the dictates of humanity we should have been rather nonplussed without him, stupid as he generally was.* At two miles' distance from the camp we were shown a rough track which led to seven Singpho villages on the Námyák River, and it is by this path that the Singphos come up and intercept the Kampti travellers on their return from Assam. A little further on, the site of a Kampti camp was pointed out, where ten Kampti travellers, returning from Sadiya, had been surprised and massacred recently by a body of Singpho robbers, and we were warned to look out on our return journey. The Kamptis afterwards told us that if it were not for fear of Singpho marauders, there would be much greater intercourse between the valleys of the Irrawaddy and Brahmaputra. On our return journey we did not camp on the same sites we had camped on going, in order not to give the Singphos a chance; we did not think they could do anything against six men armed with breech-loaders, but they might have cut up or wounded a coolie or two, and that would have hampered us a good deal. On St. Patrick's Day, descending to the Phungma again, we crossed it, barely fordable, and camped on the left bank; this place was evidently a favourite haunt of the blood-thirsty leech as one of us (who was too heavy for a light camp bed and consequently always slept on the ground) found to his cost; rolling out of his blanket in the morning, he was practically convinced (*pace* the old saying) that nothing sticketh closer than a leech, and he more resembled a limpet-covered rock than a human being. We did a lot of wading down a stream called the Pung the next day, and passing a small Singpho village called Urmphenkong we reached Langnú (the first Bor Kampti village) in the afternoon, and right glad we were to come to an anchor for a bit though our reception was not at first very reassuring. We camped on the right bank of the Námlung river, a little distance from the village. Our great anxiety was the want of food for our party so we went to interview the Raja of Langnú in his stockaded village; we sat for some time kicking our heels in the Town Hall, a house with a raised platform, in the centre of which was a fireplace; the Raja sent to say that he could not come; but on a reply being sent to him to the effect that his behaviour was not nice, and reminding him that the Kamptis who went to Sadiya were always granted interviews by the officer there, he came in state with Burmese gilt umbrellas carried over him and his brother and with gongs beating, &c. Woodthorpe made a sketch of the procession, in which a conspicuous figure was an official called the "Tongnu", who was dressed in a kilt, a black goat-skin coat, and a Burmese red lacquered helmet (like a fire-brigade man's hat); this man's duties are of various kinds, amongst them is that of public executioner, an office which he very rarely, if ever, is called upon to fulfil. In answer to an inquiry I made about the way criminals are punished, I was told that in a case of theft, where the thief would not, or could not, restore the property stolen, he (thief) was put into a species of stocks and kept in the open close to the Bápu's house until he or his friends made good the value of goods stolen; should he not be able to do this, he was turned out of the community. I fancy the custodian of Kampti morals has a pretty easy time of it, for, as far as I could judge, they seemed a very honest people; the Kampti Raja said that had he known we were coming, he would have gone to meet us and have escorted us in (I think however this was only "a manner of speaking", our coming down so suddenly on the valley without giving any notice probably saved us the mortification of being turned back, had the Kamptis got wind of our intention). On the whole we had an amusing and satisfactory interview; rice was promised us and the promise was handsomely redeemed. After the interview we "processed" through the village preceded by Deori, who carried in his hand one of the toys, a wood-cutter, whose saw was worked by a current of air moving a little wind-mill attached. The stockade was a strong one, double, with a banquette of earth about 4 feet from the ground; the total height was about 11 feet; I was told that the slaves built the stockades, and was also informed that if we had brought a couple of hundred sepoys, all the slaves would join us and go with us gladly to Sadiya: this statement should be received "with salt." As far as I could see the slaves (so-called) were perfectly happy and contented, and even supposing that we cared to have such a herd of "white elephants" in Assam, I much doubt if they would come. The Kamptis seemed a very healthy people; a few old people complained of rheumatism for which we gave them a little "vaseline" the rubbing in of which would do the affected joints no harm (and I'm afraid not much good); we saw a few cases of goitre. The Raja's brother came and took tea with us, and his wife, a comely Kampti girl (daughter of Chounubu, the Raja of Padao), brought us rice, fowls, &c. During our stay at Langnú we had a constant succession of visitors, and we showed them all our toys and entertained them to the best of our ability. A few wild, uncouth-looking Singphos came fully armed into our camp, and the Kamptis seemed much relieved when they took their departure. A very wild and dirty man, almost naked, also made his appearance, and we were told he was a "Maru"; that his tribe often lived on roots; that they were very poor, and inhabited some hills to the south of the Námkiu Valley. Some Kunnungs came to have a look at the two white men; they (Kunnungs) are an extremely gentle, pleasant-looking people, small in stature, rather fair in complexion, with their hair cut short in a fringe over the forehead; they had melodious voices and pleasant smiles. I wrote down a few words of their language which to a certain extent resembles the Singpho, about five per cent. of the words being identical; the Kunnungs are famous for their *daos*, which they manufacture from iron extracted by them from the ore found near the Nám-

* I have since heard from my Bor Kampti friends that the poor "Image" died at Langnu in the Bor Kampti country not long after our departure.—C. R. M.

Tisán river. Silver is also extracted by the Kunnungs from ore found 8 days' journey from Langnú, the silver ore is procured to the east of the Nám Tisán river on a range called Nognún near a hill called Naikon; this hill (Naikon) was described to me as shaking, but whether it was only a semi-detached rock which shook or not I could not make out. The value of silver, except as a circulating medium,* in the shape of rupees did not seem to be great among the Kamptis; the women wore a few silver ornaments in their hair; pipes were sometimes made of silver; handles of *daos* were decorated with the metal, and the trappings of the Raja's pony were also lavishly embellished with the same; these were all the uses that I noticed silver being put to. Afterwards, when we were at Padao, Lúkún, the Chief Raja of the Kamptis, said that if we would visit him again, he would send us to the Kunnung villages where the silver is obtained, and he (Lúkún) seemed anxious to obtain the services of men who would be able to extract the silver from the ore; probably this was because the Kunnungs, though nominally the subjects of the Kamptis, keep the silver monopoly to themselves. The Kunnungs are, it is said, often raided on by a race called Singlengs, and carried off as captives and sold as slaves to the Phángs (the Lámás), or more strictly speaking, the Tibetans (as all inhabitants of Tibet are, of course, not Lámás). The Kamptis said that occasionally they had taken silver to Sadiya for sale; but that as the Marwaris (Kyahs), only gave them about six annas for a rupee's weight, they took none now. On the 19th March we were engaged nearly all day in buying rice at the rate of 8 seers for the rupee, at the present rate of exchange a little over a penny a pound. As we had no small change, and each man or woman only brought in a few pounds each at a time, the matter was a tedious one, and we had to trust a good deal to their honesty, a trust which was in no case misplaced. On the night of our arrival at Langnú we heard a great beating of gongs, and a great hubbub at the Bapú's (Priest's) house, but being very tired, we agreed that the inhabitants were expressing their delight at our arrival and not the reverse, and in this comfortable belief we soon fell fast asleep. I afterwards heard that the people met together to decide what was to be done about us (*i. e.*, if we should be told to return or allowed to remain), and luckily the majority was in favour of hospitality being extended to us. On the 20th March we started for the western branch of the Irrawaddy, called by the Singphos M'Li Kha, and by the Kamptis the Námkiu. The Raja of Langnú gave us a couple of ponies to ride, on one of which we put old Deori, and off we started, crossing to the left bank of the Námlúng river, near the village; on the left bank there was a detached village, about 14 houses, not stockaded; we crossed the Námlúng which was unfordable, by means of two little dug-outs. The Kampti idea of crossing a pony over the river was a very crude one; a man got in a dug-out, and pushing off from the shore, dragged the pony after him on the *up-stream* side of the boat; the result was that the poor beast, owing to the tight rope round his neck was half strangled and nearly drowned. Our Khásia coolies were far from happy during the passage, and to a non-swimmer it must have been risky work, as the dug-outs were very frail, though the Kamptis managed them with a happy mixture of skill and rashness, and no accidents occurred. At Langdao, a large stockaded village on the left bank of the Námlúng, we received a check, the inhabitants pouring out of the village with a collection of arms, *daos*, spears and a few guns; they said that they objected to our going through their lands to the Námkiu, partly because we had Laugnú men with us, with whom they were at feud, and partly because we had not asked leave of their Raja. After much talking and angry gesticulation we accompanied the crowd into the stockade and went to see the old Raja; at first he was inclined to stand on his dignity, and refused us permission to go on to the river, but we (through our interpreter) said it was absolutely necessary that we should go on that afternoon; a cloth was given the old man, and the Buddhist Priest, who swore there were evil spirits on the road, was given some rupees to bribe any of these itinerant "Nats," and having cordially (on our part) shaken hands with the Raja (a mode of procedure which somewhat astonished him), we took his consent as granted and made off for the river above Námlúng Mukh, where we struck the Námkiu; it (Irrawaddy) was 85 yards wide and not deep, in no place over 5 feet. Námlúng Mukh is, in East Long. 97°-38'-30" and North Lat. 27°-15'-30", 1,630 feet above sea level. The view up-stream was a very pretty one, and Woodthorpe made a charming sketch of the river with its "couch of snows," the lofty Námkiu mountains to the north as a back ground. The nephew of the Lángdao Raja (who seemed a very intelligent young man) informed us that the Phúngma river was only a little larger than the Námkiu at Námlúng Mukh (where we were standing), and that the Nám Disán or Tisán (D and T being used indiscriminately as in the words Túngan, Dúngan, &c.) was the same size as the Námlúng river at Langnú (between 60 and 70 yards wide). The Phúngma was crossed by the Singphos in little dug-outs, and the river, though not fordable, was not deep. The Kamptis said that to the east of the Námkiu was a range called Tchet Búm, to the east of that the Nám Tisán river; again to the east was a range called Noikon (where the silver is found), and further still to the east there was another river, which one Kampti called the Nám Poti, and another Nám Dúmai (probably the eastern branch of the Irrawaddy generally called by us Phúngma); the Kamptis all seemed to agree that the Phúngma was about the same size as the Námkiu. One man drew a rough map of the country to the east, on the sand, and insisted that the Phúngma was the same size as the Nám Tisán, and that it flowed into that river. The Kamptis said that sometimes a trading party went to the Khé Moung—(China); that the journey took them one month and eight days; that they crossed two big

* In speaking of coined silver as a circulating medium among the Kamptis, I refer to their dealings in Assam only.
C. R. M.

rivers, besides the ones mentioned, and that Singphos ferried them across. At a place called (name omitted), which consisted of about 200 houses, they bought opium at the rate of 14 rupees the seer; they said it was not so good as the Assam opium, which they could obtain after a journey which only took them half the time that it did to go to China. The Kamptis are not such inveterate opium-consumers as the Singphos. I should say that about one-third use opium. Deori informed me that if a woman used it, her child would be certain to do so, as the taste would be derived from the milk: this may or may not be the case; as I have said before, our interpreter often "romanced." At Langnú we watched some Kampti girls collecting opium, and the "modus operandi" was as follows:—With a small piece of wood about 4 inches long, having at the thick end a few small sharp iron teeth, the operator made incisions in the pod, and, as the juice came out, she wiped it off on a cloth (which is afterwards dried in the sun). Whilst we were at Námlúng Mukh, I asked for the names of the rivers which flowed into the Námkiu on either side, and I was informed that on the right bank there were the Námthúm, Námkokhas, Namyuk (this joins the Námlúng near its mouth), Námlúng, Námkang and the Phúngma; on the left bank the rivers were Nám Tisán nearly as big as the M'Li Kha (Námkiu), Námkang, Namsámá, Námsupong, Námkatnai, Námkám, Námpáp, Howenchong and Námgang. I have written down the list just as it was given me, but of course cannot vouch for its accuracy. After having rested and refreshed ourselves on the banks of the Irrawaddy, we returned to Langnú following the course of the Námlung river as far as Langdao; *en route* we noted that the Námyak river flowed in near Námlung Mukh, and the Phúngma just below the village of Langdao; both these rivers flowed into the Námlúng on its right bank. We stopped several times on the way to camp, and Woodthorpe did some work on the plane table; admiring crowds surrounded us, but, apart from their very natural curiosity, did not cause us any inconvenience. At Langdao, the Raja's nephew got me some Kampti tobacco, as I had finished all mine; it was better than nothing, but I was very glad when I got hold of my little reserve of "Pioneer" mixture on our return to Kúmki. About half-way between Lángnú and Langdao, we passed seven pillars with figures outlined on them; these pillars had been put up to commemorate some event in the history of the Kamptis. Near these pillars there was a track which led to Padao, and we saw some Kunnungs who were going to attend a market which was being held at that village. Markets are held bi-weekly in Kampti land at Padao and at Mánchi. The day had been a very hot one, and I suppose we felt the heat more owing to our having been travelling at high altitudes between 7,000 feet and 9,000 feet, the descent to 1,600 feet was somewhat trying, but it *was* a relief to walk on level ground again, and if we could have forgotten all about the return journey and its discomforts which we knew awaited us, we should have been happier. However we plucked a few violets as souvenirs, and were very glad to think we had accomplished the aim of our trip. At night we were disturbed from our slumbers by the arrival in camp of some armed men, who, quite regardless of etiquette, ran yelling into our camp with torches in their hands upsetting themselves over our tent-ropes. We turned out, weapons in hand, thinking that the Kamptis had changed their minds about us; but discovered that our midnight visitors were only messengers sent by Lúkún, the "Chief Raja" of the Bor Kamptis, and that he "invited" us to "repair to the metropolis." To pay "Lúkún" a visit at Padao was just what we wanted, so we went off the next morning taking half our escort with us, and leaving the other two men to look after our coolies and buy some more rice. After we had been ferried over the Námlúng river our route lay along a level valley covered with short "oolu" grass; the valley is divided into three plateaux, on the most southern of which the village of Langnú stood, and on the northern the village of Padao (or Múng Kámpti, as it is called in the old maps); the extreme breadth is about 25 miles, and the average width 15 miles; and the height above sea level varies from 1,500 to 1,800 feet, the number of inhabitants does not exceed 12,000, and they are divided amongst thirteen villages, the most powerful of which are Padao and Mánchi; Pánglieng is also a large village close to Padao and subordinate to it. Langnú and Langdao were in the old maps called Mung Lung. The soil of the valley is very fertile and very large crops of rice are grown, the rice being stored in excellent granaries. Blood feuds between members of different communities are not unfrequent, and the Kamptis seem to have a lively dread of the surrounding Singphos; otherwise they (Kamptis) lead a quiet peaceful life, and are certainly the most intelligent and best-behaved people on the North-East Frontier. An old friend of ours, the "Tongnú" of Langnú accompanied us to Padao (he had attached himself to us, having discarded for a time the gold lacquered Burmese helmet and the other insignia of his office). Some of Lúkún's messengers were much interested in Woodthorpe's operations on the plane table, notably so one individual, who, when he (W) was trying to "shoot" a distant point, glued his eye to the other end of the instrument; needless to relate the point was not "shot" that time. The Kamptis did not seem to object in the slightest to our survey work, unlike their more ignorant neighbours, the Singphos, Mishmis and Abors. Some very intelligent queries were put to us, particularly by the nephew* of Raja Chounuhu (Lúkún); this man had been partially educated in Burma where he had been sent as a child; he had returned from Burma seven years ago; his dress was different from the ordinary Kampti check pattern, being a colored silk "putsoe." About half-way to Padao, we came to a small wooded ravine in which there was a pool of deliciously cool water; two miles further on, on emerging from a wood, we found a large crowd of Kamptis awaiting our arrival; a large proportion were armed with *daos* and muskets, and the remainder

* This Kampti has since visited me at Dibrugarh, and has in company with two other Bor Kamptis gone down to Calcutta, Mr. Ward (the Chief Commissioner of Assam) having aided him with a money present.—C. R. M.

with *daos* and spears. We were informed that Raja Lúkún had sent out one of his nephews to escort us into the capital, in state. Two ponies were also sent for our use, and we mounted; the stirrups were very tiny (probably made to fit the naked big toe of a Kampti), and the carved wooden saddles were uncommonly hard; but as our friends, the Kamptis, evidently wished to do us honour, we accepted the situation and masked our discomfort and pain under smiling countenances. Our journey was a very noisy one; the Kamptis kept up a constant beating of gongs, and every now and then would discharge some muskets (all flint locks) in what the French call the "Moulinà Café" style, *i.e.*, holding the weapon at about an angle of 45° from the body and letting it off. I noticed that the Kamptis generally gave their weapons a push forward when firing blank; perhaps this was to remove the musket as far off as possible in order to minimise the damage in case the weapon burst, an event, judging from the state of the barrels, and the enormous charges used, not at all unlikely to occur. With occasional discharges of blank ammunition, gongs beating, banners and gilt umbrellas fluttering overhead, we noisily "processed," passing the stockaded village of Panglieng, near which we observed a pile-bridge across the Námthúm stream, the supports of the bridge being fascines filled with stones and earth, the road-way consisting of planks. We also passed some small temples *en route*, the domes of which were gilt, and in one was a gilt image of "Gautama," and in another a gilt model of a cow. Near the capital, Padao, we were met by Lúkún's two sons, and we pitched our little tent on the bank of the Námthúm stream about a quarter of a mile from the village. The Raja's sons told us that their father had gone to his "country residence" at Khongmalong, on the Námkiu river; that he had given orders for us to be well received, and that he himself would come and visit us. We tried to get a little rest after our tiring walk and still more tiring ride; but closely surrounded as we were by a dense crowd of about 2,000 people of both sexes and all ages, rest was impossible. I was very unwell, the sun having affected me the previous day, so crept into the tent to lie down whilst Woodthorpe, with his usual good nature, tried to draw the crowd off me by getting out our "stock in trade" of toys, &c. The dancing lady with the golden hair, who when she was wound up, fired off a pistol, was much admired, especially by the Kampti ladies who were very curious in examining all the items of the doll's dress; our jumping frog, in which the Kamptis (unlike the person described by Mark Twain) "saw many points," was in great request; and the growling bear was repeatedly wound up to the delectation of the "grown up" children. The Kamptis however, were not going to be deprived of the company of one of their two white visitors, so they lifted up the sides of the tent and squatted themselves down inside; this was a little too much for my olfactory nerves, and I came out and helped Woodthorpe to amuse the people. Whilst we were having an *al fresco* wash, curiosity was redoubled, and although Deori made some remarks reflecting on the want of modesty of the gentler sex among the crowd, the effect of his thinly-veiled inuendoes was very temporary. Rice for our coolies, and a squealing pig, trussed up in the most uncomfortable manner, was brought, as also fowls for our own use, and payment, though offered, was not accepted. I found that the people—men, women, and children—much appreciated the Burma cheroots of which I had brought a large supply, and I would advise any intending traveller in these parts not to forget this cheap and easily carried kind of present. The curiosity of the Kamptis was very natural, as we were the first Europeans who had visited that part of Kampti land. In 1826 Lieutenants Wilcox and Burlton, with an escort of 20 Kampti militia, had visited Mánchi from Sadiya; their route coincided with ours, or rather ours coincided with theirs up to the second day's march up the Diyun river from the mouth of the Dapha river. From that place (altitude 1,795 feet) the travellers, probably not having been told of the somewhat easier and more direct route *viâ* Kumki and the Chaukan Pass into the valley of the Námkiu, turned their steps near the Maha river, more to the north, crossing the Phungan Range at a higher elevation than we did. Wilcox did not visit Padao (Mung Kampti) or Langnú and Langdao (Mung, Lung) as the people of Mánchi and those of Padao were at that time (60 years ago) at war. Wilcox's narrative teems with information of various kinds, and we (Woodthorpe and I) often wished we had known him and could compare notes. Wilcox's after history is not known to me; but I believe poor Burlton was killed by the Khasias a few years after his expedition to Bor Kampti land. No man (except perhaps Woodthorpe) has done so much for the geography of the North-East Frontier as Wilcox, and I often wondered what his after-career had been. We tried to find out if the Kamptis kept any written records of their history; but though we were informed that they did so, and one event, *viz.*, the expulsion of Sainti Raja, was quoted to me as an instance of a record in writing, yet they either would not, or could not, show us the records. I think the latter hypothesis is the more correct, and that no records are kept. We paid several visits to the village (or rather town) of Padao; the Raja's house is built inside an inner stockade, and at the time of our visit a new Palace (save the mark!) was being erected for that Potentate. The day following our arrival (the 23rd March), Lŭkún (Chogn Chounuhu) was brought in with great pomp from his river-side villa on the Námkiu. The Raja was a fine-looking, shrewd old fellow, with a certain amount of natural dignity. Woodthorpe, before our departure, made a capital sketch of him and coloured it; the Raja asked that it might be presented to our Queen (about whom we had told him, and had dilated on the immense power she possessed). The open air Durbar, which was held in our honor, was a pretty and curious, if not a very imposing, spectacle. Lúkún (the Chief Raja, who, I was informed, originally came from Bhamo in Burma, Lúkún being a name or title (I am not certain which) given him by a former king of Burma) sat cross-legged on a curious carved wooden couch, flanked by gilt representations of dragons, and covered with a crimson cloth; his brother, the Raja of Pangleng, sat

on a carved chair on his right; in front of their father sat, cross-legged, Lúkún's two sons wearing a most dignified air, and behind was the Raja's pony covered with silver trappings; all the people were decked out in their bravest apparel; fourteen large Burmese gilt umbrellas gave colour to a picture of which the requisite warmth was supplied by the sun. One of the Raja's henchmen was gorgeous in a Chinese dress resplendent with dragons' heads and flowers; about a hundred men stood round armed with old flint-lock muskets, and behind them were rows of spearmen. The master of the ceremonies amused us very much; with a long stick in his hand he went round during the time the Durbar lasted, tapping, with no light hand, the heads of those in the front rows of the spectators, making them sit down so that the crowd behind could see. The "long stick in waiting" did not seem to discriminate between the bond men and free in the force of the blows he administered; but I must do him the justice to say that he "lightened his hand" considerably when tapping the neat, prettily decorated "top knots" of the Kampti ladies, who were mixed up with the warriors. Presents were exchanged and questions asked on both sides; the Kamptis asked if we were friends of the Burmese, and when answered in the affirmative, seemed pleased; though no actual official intercourse is now, or has been for many years, kept up with Burma, yet no doubt Lúkún recollected that it was to Burmese influence that he owed his elevation in the first instance, and probably he thought that Burmese influence might help him again, should he require aid against his neighbour of Máuchi, with whom his relations are, as of old, somewhat strained. The Kamptis also asked how large the Queen's Indian Territory was, and we tried to give them an idea of the extent by saying 200 days' long marches would not take a traveller from one end to the other. The old Raja seemed anxious to know why we had come all that way, and evidently credited us with some ulterior object. We asked again about the rivers to the east, but we got no further information than we had obtained when on the banks of the Námkiu at Námlung Mukh. On parting we shook hands with all those of the "Blood Royal." Lúkún asked us to procure him a mirror and a glass globe to put up in his house at Kongmalong, and said he would send men to Sadiya to fetch the articles, and we promised that his request should be granted. The old man also said words to the effect that he hoped we would always help and protect his "ryots" who had occasion to go to Assam for trading purposes, and that he in his turn would always be glad to see us in his country. Woodthorpe assured Lúkún that the Chief Commissioner of Assam would always be glad to further the interests of any Kamptis who came to trade in Assam, and that he (Woodthorpe) would not fail to report to the Chief Commissioner the hospitable treatment we had received at their hands. Should a party at some future date be sent eastward for geographical or other reasons, the goodwill and influence of the leading Kamptis would prove of the greatest service, at any rate from 8 or 10 days' journey east in the country inhabited by the Kunnungs on the banks of the Nám Tisán, the Nogmún Range (where the silver mines are), and up to and perhaps beyond the eastern branch of the Irrawaddy. Lúkún said that if we could stop he would send us with guides to the silver mines, which he described as being 8 days' journey off—3 days to the Nám Tisán and 5 days on to Nogmún. Unfortunately we could not stay, as we knew that it would be very difficult to get back to Sadiya (a three-weeks' journey), starting at once and carrying out our original intention of striking south from Kúmki, crossing the Patkai Range into the Turong Valley, and recrossing the Patkai Range into Assam near the Nong-yong lake. This programme we afterwards carried out, but with great difficulty, owing to the lateness of the season and the consequent increase in the size of the rivers,—and if we were to stay another three weeks, we should not be able to return to Sadiya till the next cold weather. Now that the comparatively easy route over the Chaukan Pass is known and surveyed, a trip to Bor Kampti and back presents no very insuperable difficulties, and might almost be carried out in six weeks from Sadiya. After the Darbar the Kamptis insisted that we should move our tent inside their stockade (probably that they might study us and our habits more closely); to please the people we did move, but not quite inside. We camped just outside the stockade, and the people surrounded us with presents of rice, fowls, vegetables and fruit. I had no sooner expressed a desire for a bunch of plantains than the crowd round us disappeared, re-appearing in a short time laden with plantains which they piled up round us to a height of three feet! The next morning, after having interviewed and said goodbye to the Raja, we rode off (two ponies, whose saddles we arranged in a more comfortable manner, were placed at our disposal). On arrival at Langnú we went to see the oldest Raja who had resigned in favour of his nephew; the old man received us in his house, cloths for us to sit on being placed round a blazing fire; it was literally a very *warm* reception! The afternoon was a very hot one, and the dense crowd, which closed up every aperture where fresh air could make its way in or foul air out, did not add to our comfort; however, we made our visit as short as etiquette would allow, and were delighted to find ourselves once more in the open air. After visiting the Buddhist temple, of which Woodthorpe made a pretty sketch, and watching the Kampti girls flitting about in the poppy fields collecting opium, we returned to our camp and made arrangements for a start back over the pass and into Assam. On the 25th March we commenced our return journey; the Raja of Langnú insisted upon sending his brother with half-a-dozen musketeers to protect us against any Singphos who (the Kamptis asserted) were always on the watch to waylay travellers; the Raja himself came with us for the first few miles, and his brother and the Kampti gun-men accompanied us for three marches. At six o'clock in the morning the Buddhist Priest with two of his acolytes came to wish us God-speed, bringing with them rice and flowers, which they scattered before our tent, chanting prayers, asking that we might have a safe and speedy journey back to our homes; that Singpho robbers might not molest us on the path; that we might not be delayed by the snow on the pass, and

that our sick coolies might recover. We were both much pleased with this attention on the part of the yellow-robed Bápus (Buddhist Priests). Our interpreter having told the Kamptis that we possessed a magical substance, which, thrown into the water, compelled all the fish to float stunned to the surface, Woodthorpe was asked to give an exhibition of the power of this wonderful "Vril," and a 2 oz. charge was dropped into the stream, and some large fish floated up to the top of the water. These fish were presented to Chounaisa, the "Lord of the Manor," but he very generously gave them back for our coolies, who, he said, had long marches before them, and would require all the food they could get. Our first march out of Langnú, we had pitched our camp on a ridge in circle to have the advantage of high ground in case the Singphos attacked us; unfortunately we had selected for our camping ground the usual path that a herd of elephants took to a salt-lick close at hand; the herd commenced the ascent and would have trampled us under foot had not one of our Gurkhas, with great presence of mind, moved a brand from the fire in the face of the leader, and so checked the advance. This happened at midnight. Woodthorpe and I tumbled out sharp, and accelerated the departure of the elephants with a couple of shots. It is rather disconcerting being surrounded by a herd of wild elephants at night in a forest, and although if the truth were known probably the elephants are quite as frightened and astonished as one is one-self, yet they might accidentally make a football of one. When we arrived at camp Gálút, the eastern side of the Chaukan pass, we found Mánbir Thápa and his little band of three Gurkhas with supplies of rice for us; the Lance Naik had been told to stay on the Assam side of the pass, but finding we were five days over-due, he had crossed the pass and was on his way to the Bor Kampti country to find and aid us, if possible. With men of that stamp (and I am glad to say the Regiment is mainly composed of such), one could go anywhere and do anything. Gálút is credited by the Kamptis with magical properties (whether these properties lie in the air or in the jungle I know not). One story is to the effect that "A Kampti Raja, travelling in search of a new country, drank some water out of a tree at Gálút; he at once became enchanted and exclaimed 'what a lovely country! I shall stay here for ever,' the Raja's followers denounced their chief's folly; but no sooner had they tasted the water, than they all agreed with him, and so the whole lot remained there." Another story is as follows:—"A party of travellers arriving at Gálút discovered a man with his legs crossed, and his back to a tree playing on a pipe; some of the party went in search of water, and on their return they found that the piper and their companions had disappeared, the clothes of the men being seen hanging on to tall trees, thus showing that their companions had been enchanted and had gone aloft."

We found the Diyun river in a state of flood: but Woodthorpe's engineering skill, coupled with the good work of our Gurkhas in the swimming and bridging line, saw us over our difficulties. On our arrival on the 9th day (after leaving Bor Kampti) opposite Kumki, we were fortunate to get across the Diyun (Dihing) in 4½ feet of water; the river which was then rising very rapidly, in an hour's time rose to over 6 feet, the breadth being about 70 yards; as the downpour of rain continued steadily for the next fortnight, it was very fortunate we got across in time. On arrival at Kumki we found, as had been previously arranged, that the bulk of the survey camp had gone down the banks of the Diyun towards N'Dong, a small guard of the 44th, with some coolies and supplies being left for us. We managed to get some rice out of the Singphos, who, since they had heard of our good reception by the Kamptis, were more amenable. On the 5th of April Woodthorpe and I left Kumki, crossing the Patkai range to the south at an altitude of 5,500 feet. For a week, up to Sunday the 12th, we marched down and along the banks of the Turong river, the route being a very bad one, principally owing to the rising of the river, which compelled us either to wade waist-deep in the torrent, or else to clamber, like monkeys, over the huge and slippery boulders and to cut footholds along the face of steep cliffs. One day's march was very like another, except that each day the rain descended in greater torrents, and the leeches became more ravenous, if possible, than the previous day. I have had a fair experience of leeches on this Frontier; but these were the worst; they were quite "too awful." On the 12th we arrived at a small group of three Singpho villages called Turong Ku; the inhabitants were much astonished to see us; we showed our toys, and let off fireworks, and generally tried to make ourselves pleasant. These villages or rather hamlets (the total number of houses did not exceed a dozen) are situated on the right bank of the Turong, a mile above Loglai Muikh; they are the most northerly villages in the valley of Hukong. On the 13th April we left the Turong and ascended the Loglai river on the left bank. On the 13th we bridged the Loglai by felling a large tree which stood on the right bank (some men swam over for the purpose); the river was here 65 yards wide, and the tree fortunately falling straight across covered 30 yards of the deep water; on the tree we placed a rough hand-rail, and though it (the bridge) was about two feet under the surface of the torrent we managed to get our party across without an accident. Our food now began to run short, and we were very anxious about our men, as the country in front was nearly unknown, and we could surmise pretty well what a flooded state it was all in. On leaving the Loglai we crossed a low hill, waded up the Diyun river, ascended the Diyun hill (4,000 feet) and camped on the right bank of the Nongyong river. On the 15th April, having crossed the Nongyong river (in which everything which was not wet before got wetted), we passed by the Nongyong lake or "Bhil." This piece of water, which is about ¾ mile long by ½ mile broad, has been fully described and accurately sketched by Mr. S. Peal, who visited it some years ago. After passing the Bhil, we crossed the Patkai range at an altitude of 2,860 feet and once more were in Assam; that night we camped on the northern slope of the Patkai range, on the right bank of the

Númki stream, down which we waded the next morning. After doing a great deal of wading down the Númki and Nambong streams, we came suddenly on to the Námphuk river, much swollen from the late heavy rain, and very wide and deep. Finding it impossible to cross or even to march along the bank, we had to strike into the forest again and cut our way as best we could through cane-brakes and dense jungle; that afternoon we made but little progress. Striking the river again, we camped in a piece of heavy jungle just above the level of the water; the following day we repeated the operations of the previous one, and sometimes cutting our way through the cane jungle and at others wading waist-deep along the edge of the river, we camped at nightfall on the river side, where it (the Namphúk) took a deep bend to the east. During the night the river rose so rapidly that some of our party were flooded out. As all our people were now, and had been for some days on half-rations, we were very anxious to get supplies from N'Dong; that night, the 17th, we issued the small balance of food which remained, and next morning, taking a short cut across some low hills, we again came out on to the river, now more swollen than ever, swirling by, with a deep and yellow stream some 60 yards wide. On arrival at the river, the Havildar of the 44th (Chabilal), who had accompanied us to Bor Kampti, volunteered to go across and carry the news of our arrival to N'Dong. After the departure of the Havildar we set to work to make rafts of plantain trees (there were no bamboos on the left bank), and on the 19th all the party were safely crossed, Woodthorpe, as usual, working like a Trojan, ably seconded by the Gurkhas and the Survey Jemadar, Rámphal, and his khalassis. Even our phlegmatic old interpreter "Deori" bestirred himself (seeing that starvation was imminent) and took the whole morning to make a raft for himself, which capsized as soon as it was launched! During the day we were lucky enough to find a tin of oatmeal, with which the sepoys, working at the rafts, made up a few chupattis at night. With the help of the balance of our tins of meat and soup, we made up a kind of soup for the Khasias and next morning got to the Singpho village of Shikao, where we found our Havildar and Dr. Grant, who had accompanied him from N'Dong. On arriving at Inling, after all hands had eaten a much-required meal at Shikao, we found Messrs. La Touche and Ogle ready to help us to cross the Dihing with *mans* (dug-outs lashed together), manned by sepoys principally of the Frontier Police (who were A 1 at this, as indeed they were at any hard work which was required of them). That evening we sent the sepoys across, but as the river rose so rapidly during the night, we did not cross ourselves and our coolies till three days afterwards. On the 27th April we left Mung-Lung (Mingro Samon'e) village by boat at 8 A.M. and arrived at Sadiya at 1 P.M.; at Sadiya we found Mr. Needham, the Political Officer, who had accompanied us to Bishi at our start, and to whom we were much indebted for the trouble he had taken in forwarding us supplies, dâks, &c., during our absence.

In this, I am afraid, rather rambling narrative account, the difficulties of the various routes are placed somewhat prominently forward. This is owing to the lateness of the season in which we did the majority of our travelling from Sadiya to Padao, a distance of 197 miles; now that the route is known, the journey could be easily accomplished in three weeks; from Sadiya to the first villages in the Hukong Valley, at its most northern extremity (a distance of 103 miles), the journey could be easily accomplished in a fortnight. From Kumki to Loglai Mukh, on the Turong river, a distance of 50 miles, the journey in the cold season would not take more than five days. I do not consider, in spite of the recent assertion of a traveller in the Shan States that the idea of a trade route to China from Assam *viâ* the Hukong Valley is by any means a "visionary" one. As far as I have travelled over the route (*i. e.*, up to the Turong river), it is by no means difficult in the dry season; and Bayfield, Griffiths and Hannay, in their accounts speak of no great difficulties to the east, at any rate, up to the Irrawaddy. I of course only am speaking of the physical difficulties to be met. Messrs. S. Peal and C. H. Lepper, both of whom have strongly advocated the Nongyong route *viâ* Hukong, would be better qualified to give an opinion concerning the utility of the route for trade purposes, and to give information about probable political complications.

In concluding this narrative I must express my indebtedness to Colonel Woodthorpe for the ready aid he always gave me to further the object* for which I accompanied him. I have been associated with him in four expeditions in various parts, and I have always found him ready to give a helping hand. This is the third occasion that I have travelled with Mr. Ogle in the hills, and it would be impossible to come across a more staunch companion, or one more reliable in cases of difficulty or danger. To say anything about Colonel Woodthorpe would be superfluous on my part; it is, I believe, useless "to paint the lily." I was very fortunate to have accompanied him.

Medical History of Expedition to the Singpho and Kampti country by SURGEON D. ST. J. GRANT, I.M.D., *attached to Assam and North-East Frontier Party,—Season 1884-85.*

Composition of Party.—The expedition consisted of six European officers, two Native Surveyors, two Hospital Assistants, forty-seven men of the 44th A. L. I., twenty men of the Frontier Police Force, eighty-one khalasies, one hundred and fifty-three Khasia and fifty-five Mekiah coolies, together with about twenty private servants, twelve elephants with their mahouts and charcutters.

Viz.,—to report on the passes leading into the Kampti and Singpho countries and on the countries and their inhabitants generally, for the General Officer Commanding the Eastern Frontier District.—C. R. M.

The Khasia coolies were enlisted from the Khasia Hills, but unfortunately the number obtainable was too small to admit of medical selection; two men indeed were dismissed from the head-quarter camp as quite unfit, but there remained many men of very poor physique.

The Mekir coolies were collected in the Nowgong district. These men are much inferior in strength to the Khasias; among them also no selection was possible, and many were quite unequal to the work of the expedition.

Food and Clothing of Coolies.—Each cooly was provided with a blanket coat, and a warm woollen rug. Their food during the expedition was good in kind and sufficient in quantity, except on a few occasions, when the exigencies of the journey necessitated the distribution of half rations for a short period; it consisted of rice, dhall and ghee, but was unfortunately deficient in the dried fish, and fresh vegetables, which form a staple article of diet to the Khasia. This want was in part supplied by the occasional distribution of deer's flesh, and of compressed vegetables, through the kindness of the officer in command. Opium was regularly served to the Mekir coolies, who are unable to work without it.

Date of departure.—The expedition left Saikwas Ghât in the immediate neighbourhood of Sadiya on December 19th, 1884, returning to Sadiya on May 1st, 2nd, 3rd, 1885, having accomplished a distance of nearly 200 miles in an easterly direction, together with many incidental excursions into the country by the line of the main route. The country throughout was most difficult and trying, and the weather from the commencement of 1885 very unfavourable. The marches lay either through thick jungle swarming with leeches, or over large boulders along the course of rivers, where the peepsa and sandfly abounded; on many of the marches rivers had to be crossed and recrossed constantly, and the rocks and sand by the banks tried the feet of the men after maceration in the water extremely. On the return journey the jungle paths were deep in mud, which induced painful and obstinate fissures between the toes. The whole expedition, with the exception of men detached at intermediate depôts, reached a point 40 miles from the Western Irrawaddy or Námkiu, having crossed the water shed of that river and the Diyun Kha, a pass 8,300 feet in elevation, on which the snow lay in deep drifts. From this point a small body of the strongest men accompanied the officer in command to the Irrawaddy.

Reviewing the whole expedition it was perhaps the most severe that has ever been undertaken on this Frontier. The extreme badness of the roads, the constant necessity of wading and toiling over large boulders, the persistent rainfall, the malignant attacks of leeches, peepsas, sandflies and mosquitoes, the sparsely inhabited nature of the country, the difficulty of procuring the smallest quantity of supplies locally, the extraordinary denseness of the jungles, and the fear inspired among the natives by the deplorable destruction of two coolies by a tiger, all conspired to render the expedition arduous in the extreme.

Diseases and Casualties.—Naturally the largest number of patients appeared among the coolies; as no medical inspection having been possible, many weakly men quite unfit for the hardships they had to endure, were included in their number. Their rations also were different from their accustomed diet, whereas the sepoys and khalassies enjoyed even better food than they usually provide for themselves in a station. The great severity of their labour, combined with their scanty clothing and carelessness in hutting themselves and cooking their food exposed the coolies particularly to the onset of disease.

Diarrhœa from half-cooked food, acute *intestinal catarrh* from exposure, and *dysentery*, were the most prevalent and fatal diseases; nearly every cooly at some time during the expedition suffered from one of these maladies. It is remarkable that in spite of the constant exposure, only three cases of *pneumonia* occurred, all ending in recovery. I am inclined to think that the blanket coats, which well protected the chest, while the legs and extremities were left exposed, procured this immunity from chest complaints.

Symptoms of Scurvy frequently appeared, but the supply of lime-juice was abundant, and the disease never developed beyond sponginess and soreness of the gums.

Diseases and Casualties.—Parasitic skin diseases were common among the coolies, but as a rule, were readily relieved by salicylic ointment.

Wounds, cuts, and abrasions were frequent owing to the badness of the roads; the compound tincture of Benzoin was found invaluable in their treatment. One case of fracture of the left ulna occurred, the result of a fall.

Foot sores.—The sufferings of all the natives from œdema and ulcers of feet and legs were very great. Marching through drenching jungles alive with leeches, climbing over rough boulders, wading through mud and water while constantly exposed to the peepsa by day and the sandfly by night, reduced the men to a pitiable condition. The ulcers were usually small and intensely painful, but when complicated with œdema, large masses of tissue about the malleoli frequently broke down causing open sores of great severity. Numbers of men became inefficient through this cause, and on the return of the party to Sadiya 50 men were temporarily crippled by fissures, sores, and swelling of the feet.

The Mekir coolies suffered more severely than the Khasias, their physique being greatly inferior and their constitutions undermined by habitual opium eating. There were few of them who had not at some former time suffered from dysentery; in a *post mortem* examination of one, who died from excessive indulgence in alcohol on his return to Sadiya, I found, in addition to old standing lesions in the lungs, the large intestine one mass of old dysenteric ulceration, its walls absolutely translucent in many places; I believe this condition is common.

Sepoys.—The health of the sepoys was excellent throughout; these men had all been medically inspected, and with the exception of one man to whom I demurred, and who finally

broke down, were all of exceptionally fine physique. Slight cases of diarrhœa, fever, and foot soreness, occurred among them, but only three men became unfitted for duty. No deaths occurred.

Khalassies and Private Servants, being subject to no medical inspection, included many men unfit for the hardships of the expedition, and suffered proportionally. Several severe cases of dysentery and fever occurred among them. One khalassie who remained in Sadiya died of broncho-pneumonia, another on his return to Shillong of diarrhœa.

Two coolies were killed by a man-eating tiger; one cooly and one mahout absconded into the jungles and were not recovered :—

Casualties.—Cause of death :—

	Coolies.	Khalassies.	Mahout.
Dysentery	4	0	0
Diarrhœa	4	1	0
Killed by tiger	2	Broncho-pneumonia 1	0
Lost in jungle	1	0	1
Exhaustion	1	0	0
Alcoholism	1	0	0
	13	2	1

The water-supply was usually abundant and good; when the camp halted for any time in one place conservancy arrangements were carried out and temporary hospital sheds erected; on the return march stringent precautions were adopted to prevent the coolies mixing in the Sadiya, Dibrugarh, and Gauhati Bazars.

Medical Assistance to the Singphos and Kamptis.—The villagers applied in large numbers for medicine, chiefly for the relief of goitre, which is almost universal in the Singpho communities, yet I only noticed one case of cretinism combined with enlarged thyroid. A large supply of red iodide of mercury had been taken, from experience of its value among the Daphlas last year, and in many cases produced very good results. Many patients suffering from parasitic skin diseases were treated successfully with carbolic and salicylic ointment. In several cases teeth were extracted for severe tooth ache, and one interesting dental subject appeared in a boy who had an extra row of incisors in the upper jaw standing out at a sharp angle, causing ulceration of the upper lip and much discomfort; they were extracted and the result gave great satisfaction in the village. A severe case of compound comminuted fracture of the left humerus, close to the head of the bone, with laceration of the right shoulder, resulting in abscesses burrowing over the whole extent of the supra scapular fossa, pectoralis major and deltoid muscle, came under my notice. The injuries were caused by a tiger, which seized the man while sleeping. The broken limb was set in splints of bamboo, and the abscess cavities washed out daily with weak carbolic lotion. The patient made a good recovery. In connection with this case I wish to mention the unremitting care and skilful attention of third class Hospital Assistant Hyder Khan, in whose hands I left the patient on my departure from Daphla camp.

A case of hydrocele of the cord was tapped; the patient was the son of the Gam Budha of Tuila in the Kumki Valley. A case of epilepsy, son of the Gam Budha of Bishi, was treated, and in addition many minor cases, surgical and medical, were almost daily attended to. In no case would the people permit themselves to be vaccinated, though an abundant supply of lymph and crusts had been provided.

Medicines and Supplies.—The supply of medicine was on the whole satisfactory; temporary inconvenience was experienced from delay in the sending of an extra supply from Dibrugarh.

The drugs found most useful were *carbolic and salicylic* acids, invaluable in the preparation of ointments for ulcers resulting from leech and peepsa bites and for parasitic skin diseases.

Tinct. Benzoin Co. for wounds and large ulcers.
Castor oil and Sulphate of Magnesia.
Ipecacuanha Radix. Pulv.
Ipecacuanha Pulv. Comp.
Tinct. Opii.
Acid sulphuric Dil.
Spte. Etheris. Nit.
Sulphate of Quinine.
Lime-Juice—Most valuable throughout as an antiscorbutic.
Chlorodyne.
Red iodide of mercury used in large quantities for reduction of goitre.
Cinchona Febrifuge—I cannot recommend, its action is slow and uncertain, and the gastric disturbance it occasions very unpleasant.

The absence of Bromide of Potas. was to be regretted.

The delay in obtaining stimulants from Dibrugarh was severely felt. In this connection, I may mention the excellent services of the self-taught native compounder and dresser Yad Ali, a man of great intelligence, who proved himself a most valuable assistant throughout.

Remarks.—In addition to the hardships inseparable from marching in wild countries, the following causes, in part preventible, are, I think, answerable for casualties and sickness :—

(1) Men accompanying the expedition physically unfit to undergo hardship.
(2) The carelessness with which the coolies hut themselves after the march.

(3) Haste and carelessness in the cooking of food.

(4) Absence of nitrogenous food in the form in which the coolies are accustomed to it.

(1)—It would be advisable that all members of such expeditions be medically examined as to fitness before starting. In face of the difficulty of obtaining sufficient strong-bodied coolies, recruiting from the local jails might be considered.

(2)—If possible water-proof sheets should be supplied: one between every two or three men would be sufficient, and the sirdars should be made responsible that the coolies provided themselves with proper shelter.

(3)—This, which is a fruitful cause of sickness, might be rectified, as the coolies have no caste prejudices, by having the rations of all cooked in a few large vessels, certain men being detailed for this purpose, and a competent khalassi made responsible for thorough cooking and equal distribution.

(4)—The lack of the dried fish to which the Khasias are accustomed is a great loss to them; it can be obtained in Shillong, will keep indefinitely and might be carried easily, as bulk for bulk it is vastly more valuable as a food stuff than rice or dhall.

Additional notes on Flora and Fauna.—The country abounds in wild animals of all kinds; tracks of elephants, rhinoceros, buffalo, tiger, leopards, and other were common. Milikin were occasionally seen; many large *sambars* and barking deer were shot by the sepoys at the various depôts. The common brown monkey and the black *hullak* were in great numbers. A few snakes, all of a harmless kind, were killed; one large python was surprised in the jungle; centipedes, scorpions and large hairy spiders were common; *mahseer* abounded in the pools. Pheasants (*kalij* and peacock), partridges and jungle fowl, were commonly met with. The toucan or hornbill was seen in large flocks. The Singphos domesticate buffalo, pigs, and fowl.

Flora.—On the low ground near the river (the jungle usually consisted of dense bamboo thickets, while on the hills it consisted of forest trees, tangled with creeping plants and cane), the commonest trees are the Arjuna, *Lagerstræmia regina*, the cotton tree, *Bombax Malabarensis*, the wild jack, *Artocarpus Chaplasha*, the Mundus, *Erythrina indica*, and many kinds of figs. In the Dapha Pani Valley, there were a few specimens of *Vateria lanceæfolia* or *moah*. The elephant apple, *Otenga*, is also very common. The undergrowth is rich with luxuriant *Salaginellala* and ferns; of the latter the commonest are *Polypodium excavatum*, *P. Lucidium* and *P. Parasiticum*, *Pterys multipida* and *Pt. Graminifolius*. *Adiantum sp* (?) with many species of Asplennius. In many places along the Diyun Kha the *castor oil* plant grows wild.

Four species of *ceratastemma* in beautiful blossom were common. *Solanum stramonifolius* luxuriated in old cultivations round the villages, a few *sago palms* and many *screw palms* were seen. Rubber trees, *Ficus elastica*, abound.

Wild limes were found in great quantities and another antiscorbutic in the *Begonia* was common. *Alpinia bracteata* is abundant, affording good fodder for elephants. *Plantain* trees were very numerous. *Epiphytal orchids* of all varieties covered the forest trees.

On the pass above the Diyun Kha, *Rhododendrons* were seen in flower. A few trees strongly resembling the *Tamarix* were seen at a distance, but I cannot think this tree grows in these regions. The *Semecarpus anacardium*, or the blistering Bhela, caused some painful accidents: men incautiously felling this tree were sprinkled on the arms and face by its sap, which produced painful erythema. The Singphos and Kamptis universally cultivate rice, opium, and tobacco.

Extract from the Narrative Report of the Baluchistan Party by CAPTAIN R. A. WAHAB, R.E., *Officiating Deputy Superintendent, Survey of India,—Season 1884-85.*

Except in the Kachhi there is nothing in the whole country under report that can be called a town; the inhabitants as a rule lead a wandering life, moving about according to the season of the year wherever grass and water for their flocks are obtainable; the only permanently inhabited sites in the Marri country are Kahán, Mamánd, and Kolu, each of which is situated in a cultivated valley of considerable extent.

The Kolu valley has not yet come under detail survey; it is however the most extensive of the Marri valleys, its length from east to west being about 20 miles, and its width probably 3 or 4. It is the most northerly of their settlements and from its elevation, nearly 4,000 feet above sea-level, its climate is fairly cool.

Kahán, the residence of the principal sirdars of the Marri tribe, is a village of the usual trans-frontier type, an enclosure about 100 by 150 yards surrounded by high mud walls, flanked by semi-circular towers. The principal entrance is on the eastern side, and near it and outside the fort are a number of huts and blanket tents, in which live the poorer portion of the community, while the interior is occupied by the sirdars and their immediate retainers. The average elevation of the valley is about 2,400 feet, its length from east to west 18 miles and width 4 miles, of which area about half is under wheat cultivation. Kahán has an historical interest from its gallant defence in the first Afghan war by Captain Brown with a small detachment of native troops; originally sent with the idea of holding the Marris in check by the occupation of their principal stronghold, he soon found himself besieged and cut off from all chance of relief. Half his little force was surprised and cut up to a man almost within sight of the garrison, while attempting to return to Phuleji to bring up further sup-

plies, and a relieving force sent with a convoy later on, in the middle of the hot weather, after experiencing fearful sufferings from heat and thirst, met with a similar fate and their arms, ammunition and artillery fell into the hands of the Marris. At last when all hope of relief was at an end and his supplies were exhausted, Captain Brown agreed to surrender the fort on condition of being allowed to retire unmolested, and, to the credit of the Marris be it said, these conditions were faithfully kept. The captured guns were never retaken, and one still stands on one of the towers of the fort.

At Khatan, three marches north-west of Kahán, the petroleum springs mentioned in in last year's report are still being worked, but the operations have not got beyond the experimental stage.

Mamand lies about 25 miles north-west of Kahán, at an elevation of 2,600 feet; the valley, which is about 4 miles long by one and a half wide, almost entirely covered with wheat cultivation, is surrounded by high hills, and except from the north-east is only accessible by very difficult *tangis* or defiles. The village is a mud-walled enclosure much smaller than Kahán; little is obtainable in the way of supplies, indeed throughout the season the detached parties in the Marri country had to send to Kahán for all their supplies, often from a distance of 30 miles and upwards.

The Harnái valley is a strip of open ground averaging 4 miles in width, lying between the high range, which extends westwards from Zarghún to Sialu, and the mass of broken sandstone hills which separate it from the Bolán. The valley is watered by several perennial streams which, rising among the high mountains to the north, cross it from north to south, and piercing the southern barrier by narrow and difficult gorges unite lower down to form the western branch of the Nári river; the elevation of the Harnái district is from 5,200 feet at Mangi on the west to 1,800 feet at Spintangi near its eastern end. The range immediately north of it is the highest in Southern Afghanistan; Zarghún which divides it from the Quetta valley rises to 11,700 feet, Kalipat to 11,400 and many other peaks exceed 10,000 feet. The southern face of this range is a bare rocky scarp, the reflected heat from which is doubtless the chief cause of the great heat felt in the valley during the summer months; on the northern slopes juniper forest is met with in several places, but the supply of timber in any way suitable for building purposes is very scanty and is being rapidly exhausted. The climate of the Harnái valley does not appear to be a healthy one, the extremes of temperature are trying to both the European and Native of India, and for upwards of a year cholera has been more or less prevalent among the labourers on the railway.

The principal towns in the area surveyed in the Kachhi during the season are Gandáváh and Shorín. Gandáváh is a place of considerable antiquity, and from its position at the mouth of the Mula pass, the easiest and most important pass between the Sind plains and the Kalát plateau and Baluchistan, is still a place of some commercial importance. There is a well-stocked bazaar, and a large proportion of the inhabitants are Hindus. The town is enclosed by a dilapidated mud-wall in places 30 feet in height, and the site itself is elevated some 15 feet or more above the surrounding plain, probably on the debris of an older city. A considerable area is taken up on the north-west corner by the "Miri" or citadel of the Khan of Kalát who usually makes Gandáváh his winter residence. The place is well supplied with water by canals from the Mula river.

Shorín is about 20 miles north of Gandáváh near the mouth of the Gazak pass to Kalát; here too supplies of all sorts are abundant.

The most important road in the area under report is the Harnái line by which the railway to Pishín is now being constructed. During the cold weather work was in full swing; encampments of coolies employed on the works (almost all imported from India) were scattered along the whole length of the line quite unguarded, but to all appearances as secure as if in India proper, and this be it remembered on the border land between the Pathán and Biluch tribes, only a few years ago one of the most lawless tracts on this frontier. Numerous branch roads are being opened out to connect the various military outposts with the railway—one leaves the railway at Gandkindaf and follows the Beji valley to the Thal-Chotiáli post; another leads from Suneri in the Harnái valley by the Warikh pass to the same place, and another is projected from Harnai by the Mihrab Tangi, one of those remarkable rifts which pierce the high limestone ridge north of the valley to Smalan and Bori.

9. From the Kachhi several passes lead into Baluchistán, the principal ones, as already mentioned, being the Mula and the Gazak or Takári pass. The Mula has been often traversed and is well known; the Gazak pass would give a short direct line to Kalát, but is not in its present state a practicable road for laden camels, though it is believed that a fair road could be made at a very moderate cost. These passes will be reported on hereafter when they have been surveyed throughout.

10. One of the most important results of the season's work on the Deraját frontier was the exploration of the Vihowa pass. This has been proved to be a good road passable by laden camels the whole way from the British frontier to the Musa Khel Sahra, from whence to Bori and Thal-Chotiáli the road has been recently traversed by the Zhob expeditionary force.

The distance from Vihowa post to the Musa Khel bazaar is 66 miles, in 6 marches, and at all the halting-places water is good and plentiful, and except at the entrance to the pass where the first halt would be made, grass and fuel are said to be abundant.

11. The other passes to the south leading from Dera Gházi Khán to the Khatran valley and thence to Thal-Chotiáli have been frequently traversed by our troops and are well known.

Extract from the Narrative Report of LIEUT.-COLONEL A. PULLAN, S.C., *Deputy Superintendent, Survey of India, in charge Cutch Topographical Survey,—Season 1884-85.*

The season's operations of topography were executed on three different scales, *viz.*, 2 inches=1 mile, $\frac{1}{2}$"=1 mile, and the large scale of 12 inches=1 mile of the city and environs of Bhuj, aggregating a total of 2,265 square miles.

During the season 233 stations were fixed by theodolite traverse; 183 of these are situated in the Rann, and have been plotted on the plane-table sections, as closing points for the interior surveyors; the remaining 50 are those in connection with the large scale survey of Bhuj, 23 of which are marked with rectangular masonry pillars, constituting the boundary of the military station of Bhuj; the remainder (27) of less importance, have been marked by small rectangular stone pillars embedded two feet deep, having the survey mark, and number of traverse station marked with red paint on the exposed part of the stone.

Extract from the Narrative Report of the Cutch Topographical Party from information supplied by MR. N. C. GWYNNE.

Sheets 52 and 53 embrace a portion of the great Rann lying between the island of Pránthal in Cutch and the district of Párkar in Sind; the whole country is a barren waste containing large deposits of salt and during the monsoons this tract of land is under water. There are two cart-roads which serve as lines of communication between Cutch and Párkar which are only open for traffic during the dry season.

Sheet 54 contains the island of Pránthal with an area of about 206 square miles containing 11 villages, the largest being Bela, population 4,191; the next one of importance in the island is Lodhrani, population 1,855; these two villages are situated on the direct lines of communication between Pránthal and Párkar. The general appearance of the island is hilly, the highest point being 804 feet above mean sea level, and while the northern face of the range of hills is exceedingly steep, towards the south the angle of depression is not more than 15°. The remaining area of the sheet contains Rann similar to that in sheets 52 and 53.

In this connection I would point out that the islands of Pachham and Kharir and the broad grassy waste of Banni would, with a little care and conservancy, be clothed with forest, which would inevitably produce and retain moisture alleviating and materially altering the arid climate of the Rann and, by an increasing water supply in streams and tanks, change an unprofitable desert into a smiling well-cultivated plain. The noticeable silting up of the streams and water-courses, gradual but sure, should meet with the serious attention of the Cutch Government, and that without delay.

Sheet 55 is more or less hilly, the southern half containing a few conspicuous rocky hills clothed with large cactus bushes. Towards the north of the sheet the country settles down into a level plain having a fair amount of villages, and is thickly studded with the cactus and jál bushes; the latter grows abundantly in Cutch and is eaten largely by camels. The only towns in the sheet are Rahpur, population 4,603, and Fategadh, population 4,158.

Sheet 56 contains along the north a range of rugged hills, the highest point being 756 feet above mean sea level. The range stretches across the sheet from west to east terminating in the Rann; the southern half of the sheet (with the exception of the south-east corner) is a low flat and well cultivated land bordering on the little Rann, and contains several villages.

There are no roads or rivers of any consequence passing through the season's work.

The city of Bhuj is the capital of Cutch, and is situated in a very picturesque valley, surrounded by extensive gardens and tanks. His Highness the Rao's palace is situated within the town and near the western wall, and to the south-east lies the well known hill of Bhujia on the summit of which is a temple called "Snake Temple." The story in connection with this temple is that an enormous cobra has his residence within, and that he appears once a year above ground to receive milk from the many worshippers who visit the spot. The town is surrounded by a strong fort wall and has five gates named as follows: Mahadeo Naka, Wániwar Naka, Bhir Naka, Sarpat Naka, and Patwari Naka; it covers an area of about 0·5 of a square mile and contains a population of 20,785 souls, and is noted for its manufactures of silver. Some very good cutlery is also made in Bhuj.

Extract from the Narrative Report of LIEUT.-COLONEL W. F. BADGLEY, S.C., *Deputy Superintendent, Survey of India, in charge Gujarat Survey Party,—Season 1884-85.*

Programme.—The work proposed for last field season was the triangulation and traversing of sheets 87, 88, 103, 119; the topography of sheets 214, 215, 246, 487, parts of 182, 184, 190, and some re-survey in 123 and the traversing of Baroda State boundaries in sheets 123 to 128; but owing to the extreme unhealthiness of the season a part of this had to be left incomplete.

Country surveyed.—The Dohad and Jhálod sections of the Panch Mahals form a plateau about 950 feet above the sea. A good road from Godhra branches half way to the two towns from which the Mahals are named and ascends by easy inclines, but in other places the edge

of the plateau is traversed by but a few unmade tracks which are difficult and often dangerous for carts, as, for instance, that to the east from Báriya, where carts have large drags of brushwood (on which all the men available sit) tied to them in descending, and occasionally fatal accidents happen by the breaking away of a cart. The roads on the plateau are all fair-weather tracks, often roundabout on account of the hills, ravines, and rivers which, when large, can be crossed by carts in a few places only.

To the north-east our work included a part of the Kusalgarh State, a fertile valley where rice as the staple was grown without irrigation. I am much obliged to the Rajah of Kusalgarh for his kindness in provisioning my camp free of cost while I was inspecting the work in his territory.

Extract from the Narrative Report of LIEUTENANT F. B. LONGE, R.E., *Officiating Deputy Superintendent, 4th grade, officiating in charge Konkan Survey,—Season 1884-85.*

THANA.—The character of the country surveyed this year differs little from that in which the party was employed during the preceding season. The only open ground is that lying between the Bombay, Baroda and Central India Railway and the sea. Looking eastwards from the Railway, the hills have the appearance of being one continuous range covered with heavy forest and running north by east, but, in truth, this tract consists of numerous ranges overlapping each other; further east again, we come across groups of hills, generally consisting of a high central peak with spurs jutting out in all directions. The most conspicuous of these groups are Segva, Gambirghar, and Muramba. Eastwards from Muramba, the country changes; from groups of hills we come to series of plateaux, intersected by deep ravines, the sides of which are covered with dense jungle and forest.

The Vág river, which for about 6 miles bounds the district on the east, at a level of about 350 feet above the sea, flows between abrupt forest-clad hills, rising to a height of 1,500 feet and giving a very wild aspect to the Vág Valley.

The Dhamanganga flowing north-east through Kachigaon forms the district boundary for 9 miles and passes into the Daman State at Mohana. Near Achari the river bed is crossed by some remarkable trap dykes, one of which forms a natural dam, over which the river falls a height of 15 feet, and near the village of Mohana, on the left bank of the river is a hot spring. Besides these the Kálu and the Varoli rivers, both of which rise in a group of hills of which Segva is the most important, flow through the country under survey.

The Bombay, Baroda and Central India Railway runs through the western portion of the district, and the railway stations falling within the area surveyed this season are Gholwad, Vevji, Sanján and Bhilad. A made road connects the Vevji Railway station and Umbargaon, and another runs from the Sanján station to the Khatalvadi "Bander." Cart tracks are numerous, and the whole country west of the Talasri plateau is connected by them with the several railway stations and ports, and along them passes a large amount of wood, grain and grass, to find a way eventually by sea or rail into the Bombay market.

The most important places are on the coast, and all have a small export trade in wood and grain. They are, Gholwad and Umbargaon, the head-quarters of a sub-division of the Dáhánu Taluka with a Mahalkari's post and sea customs offices, and Moroli and Kalai, both fishing villages, each containing ruins of Portuguese mansions and the remains of what must have been fine gardens. At Sanján on the right bank of the Varoli River; and 4 miles east of Umbargaon, the first Parsi emigrants landed about the year 716 A.D. and placed themselves under the protection of Jadi Rana, the Chief of Sanján. Here there are the ruins of a fort and of a Portuguese chapel. Talasri is a market town on the northern edge of the Sháhapur Taluka, which is situated on a plateau about 8 miles long from east to west, and ½ to ¼ mile in breadth, at an elevation of from 1,400 to 1,600 feet above sea level.

Forts.—There are many ruined fortified Portuguese mansions all along the coast, the most noteworthy being in Salsumba near the Vevji Railway station and Dindu fort on a small eminence in the village of Phansi. Indragad fort on the boundary between Karmbeli and Pali stands on a hill 350 feet high commanding the Kolai creek; the walls still remain, though the interior buildings are in ruins. Kajali Fort on a hill 390 feet high, and Segva Fort (1,218 feet) in the village of Karanjvihira, in ruins, has some rock-cut cisterns within the outer walls.

Gambirghar Hill (2,252 feet), in the village of Vahali, is the highest point in the country under review, and consists of a central peak, flat-topped and surrounded by a number of lower pillar-like peaks, from which spurs shoot out in all directions; on the scarp of the central peak are a few rock-cut cisterns.

BELGAUM.—The country in which the preliminary operations of triangulation and traversing were carried on contained the towns of Kilur, Khánápur, Sampgaon, Sháhapur, Hongal, Nandgarh and Belgaum Cantonment. That to the west of Belgaum is undulating, a few of the hills rising to 1,000 feet above the plain; while to the east, the hills are lower, flat-topped and covered with jungle. Roads are numerous and good.

The Malprabha River, which flows into the Krishna at Sanján Dhanur, drains the southern portion of the work; the northern drainage is carried off by several small streams into the Ghatprabha, which again joins the Krishna at Chimalgi.

KOLABA.—The chief towns in the area under survey were—

Roha, the head of a taluka with a Post Office and Bunder. It has water (tidal) communication with Bombay.

Nizampur, formerly the head of a peta, with Post Office and a trade in wood.

Tala, with Post Office, School and Fort.

Murrud, the head-quarters of the Habsan State and the residence of the Nawab, has communication by steamer with Bombay and Goa, and by State road with Rewadanda and Borli.

Janjira, an island on which are the town and fort of that name, is also in the Habsan State and 2 miles south of Murrud.

Ashtami, opposite Roha on the Kundalika river, has a trade in copper vessels, a bazaar, and a letter box.

Mángaon, 5 miles south of Murrud, has a Post Office, Police station, and is in tidal water communication with Bombay.

Indapur, 8 miles from Mángaon and Tala, has a Travellers' bungalow, besides the usual public offices.

Numerous old ruined forts came under observation, the chief of which were—

Avchitgad and Surgad, near Roha. Kurdo, half way up the ghats in the village lands of Jita. Mashidwadigad, east of Nizámpur. Talagad, overlooking the town of Tala. Janjira and Kansa, both sea bound, the walls of the former enclosing the town of that name.

The Kundalikakhar river, rising in the ghats near Pimpri, flows past Roha and Ashtami and empties itself into the sea at Rewadanda.

The Kal, rising on the southern face of the Dipat watershed, passes by Umbarda, Nizampur and Mángaon, to join the Sávitri at Dasgaon. It is tidal as far as Goregaon.

The Kalnai, whose source is in the Bhor State near Ghol, flows past Sandosi, Nizampur and Varangi, and skirting Raighar empties its water into the Sávitri.

The Ganga, from which the water-supply of Roha is obtained, rises in the hills near Karivna.

Extract from the Narrative Report of MR. W. H. PATTERSON, *Officiating Deputy Superintendent, in charge Bhopal and Malwa Survey,—Season 1884-85.*

Description of country plane-tabled, sheet No. 58.

The greater portion of this sheet consists of hilly ground covered with thick jungle, but there are some open bits to the north-east and south-west, which are well cultivated. The hills on the north and west reach an altitude of some 1,600 feet above sea-level. The Som river, which flows eastwards, near the northern limits of the sheet, forms the boundary between the Dúngarpur and Oodeypore States. Most of the area in this sheet forms part of the Dúngarpur State.

Sheet No. 59.

The northern half of this sheet contains some very intricate ground full of deep ravines, forming confused masses of hills with here and there flat tops and covered with heavy jungle. The hills are nearly all of an uniform height, and this added much to the difficulties of the plane-tablers, who were unable to see the trigonometrical points. Southwards the hills gradually disappear and the harsher features give way to undulating ground covered with jungle. The hilly portion belongs to the Dúngarpur State, and the small area of open country, south of this tract, forms part of the Idar State of the Mahi-Kántha Agency, Bombay Presidency. The boundary here is in dispute and a strip of hilly country is claimed by both Chiefs (Dúngarpur and Idar).

Forts.

There is a fort at Bhorai in sheet 58 which has been recently constructed by the Oodeypore Durbar: it is situated on an isolated hill in a commanding position, and is substantially built of masonry in the form of a square with bastions at the four corners; one bastion is fitted up with suitable rooms for the accommodation of His Highness the Maharana of Oodeypore. This fort was built in consequence of the sudden rising of the Bhorai Pal of Bhils a few years ago, which was with difficulty suppressed. There is also a small fort at Kherwára occupied by the Meywar Bhil Corps; a ruined fort at Meghraj; a small out-post at Valicha; a square enclosure at Genji, and forts at Dewal and Antri, besides small walled enclosures for the Durbar *thana* guards at Punali, Ganeshpur, and Dhambora.

Round the city of Dúngarpur there is a long line of outer and inner defences, and the approach to the city is through five gates where guards are kept day and night; the outer line of defence, which is a stone loop-holed wall of some 4 miles in length varying in height from 10 to 30 feet, is taken along the ridge of the hills surrounding the city: there are 95 bastions, 13 of which are made for small cannon, the rest for matchlocks and small arms.

The fort at Dungarpur is on the highest part of the hill (1,403 feet) overlooking the city, and covers an area of some 10 acres. Immediately below it stands the palace of the Mahárawal. To the north of the city there is a detached hill (1,149 feet) which commands an unbroken view of the country for 2 or 3 miles, north, east and west, and on which a small fortress with two towers stands.

Towns and cities in Oodeypore State.

The cantonment of Kherwára, Lat. 23° 59′ 7″ / Long. 73° 36′ 21″ (of the church), is the head-quarters of the Meywar Bhil Corps, and is situated on the bank of the Bhadesar Nala. The hills in the vicinity are bare and rounded and present rather a dreary aspect. In the valleys there are a few large isolated trees, and these constitute all the timber to be met with in and about the cantonments, except some fruit and other trees in gardens. On the southern bank of the stream, on a hillock

rising about 40 feet from the plains, there is a small fort covering an area of about 1½ acres; its walls are about 16 to 20 feet high and about 5 feet thick, and it has three towers. A guard of the Meywar Bhil Corps is stationed here as it contains the Treasury, the Ordnance stores of the Regiment, and the Jail. In the cantonments are a Post Office, a travellers' bungalow, a *Sarai*, a Mission House and a Protestant Church, besides the usual bungalows for the officers of the Regiment. The bazaar is fairly well supplied and contains some large shops. Special quarters have been constructed in the cantonment limits for the *vakils* of Oodeypore and Dúngarpur, who reside here permanently with a detachment of cavalry, provided by their respective Durbars. The area of the cantonment is 499·2 acres, the limits of which are marked by 13 masonry pillars about 5 feet high. The height of the parade ground is 1,050 feet, and that of the hill on which the Political officer's flag staff stands 1,086 feet above sea-level.

The principal villages (for there are no large towns) are—

Chani Lat. 23° 57′, Long. 73° 34′, the residence of a small Thakur.

Thana Lat. 23° 59′, Long. 73° 30′, on the road leading to Idar; contains a large tank.

Kanbai Lat. 23° 54′, Long. 73° 32′, a camping place for troops, with a fair-sized tank and near it a fine stream.

Bhanda Lat. 24° 0′, Long. 73° 34′, a large village on the road to Kotra; to the south of it there is a fine sheet of artificial water.

Kalianpur Lat. 24° 0′, Long. 73° 45′, the head quarters of a local Governor from the Oodeypore Durbar; contains a fort: it is situated on the extreme northern limits of the survey.

Toker Lat. 23 50′, Long. 73° 52′, a large trading village picturesquely situated on the slope of a hill.

The population of the above villages cannot be given as the information was not obtainable from the Oodeypore Durbar.

Towns and cities in Dúngarpur State.

The chief town, Dúngarpur, where His Highness the Maharawal resides, is situated in a hollow between two hills, and is in the shape of the letter V, the apex being closed in by the spurs of the two hills Dhan Mata and Kalesar, which almost meet at this point, where the main road from Báuswára enters the city. The hill on the north and east rises to a height of 1,360 feet, and that on the south to 1,403 feet, while on the west there is an isolated hill 1,066 feet in height which joins on to the southern or Dhan Mata hill, and at its base is the "Patela" gate, through which a road from the west enters the city. Further northwards is another isolated hill, 1,140 feet high, at the eastern base of which there is the Geb Ságar lake, and on its edge is the "Raja's Chatri" gate, through which the road passes leading to Kherwára. In addition to the natural defences formed by the hills surrounding the city, a long line of stone wall runs along their ridges, and as an extra precaution against surprises, the hill sides have been denuded of trees, thus giving an unbroken view along the outer slopes of the hills. The Geb Ságar lake, which is about 4 miles in circumference, is situated on the north of the city; the side nearest to the city has a stone pavement with steps leading to the water. On the west of the lake there are three tanks, the Talai, Sabela and Sonari, and the supply of water from one to the other, in the order named, is regulated by large embankments 13 to 15 feet high, through which temporary cuttings are made. The level of the country at the points where the city walls reach the plains is about 931 feet, and that of the palace and of the highest blocks of the city buildings about 1,000 feet. Looking towards the palace from a little distance beyond the city the view is very picturesque; the white minarets and domes of the palace stand out in striking contrast against the sombre background of the hills, while the city nestles in the hollow, encircled by the long loopholed wall with its masonry bastions. The streets in some parts of the city are narrow, but the buildings are chiefly of stone and lime, and are roofed with tiles. There is a Post Office, *Sarai*, Jail, and several Hindu temples within the city limits, and a fine Mahomedan mosque is now in course of construction. A new palace or summer house is being built for the Maharawal on the banks of the Geb Ságar lake which is to be named the Uday Bilas; it is supposed that a lakh of rupees will be spent on its construction. The rooms are faced with slabs of marble, and the rest of the material is stone procured from the quarries not far from Dúngarpur. In the city there are several wells, and a new reservoir is being constructed for the storage of water on the Dhan Mata hill near the fort. Several *chatris* (cenotaphs) of the Maharawal's ancestors still exist round about the city, and some old temples which are gradually falling into decay; there appears to be a superstitious feeling among the Rajputs that the present generation should not look after the buildings constructed by their ancestors, but that their mission is to set up new temples, &c.; this will account for the many ruins to be seen. At Surpur Ghât about 1 mile from the city is a group of temples and *chatris*, and an enclosure in which elephants are let loose to fight.

The city of Dúngarpur, Lat. 23° 49′ 41″, Long. 73° 43′ 27″, contains 1,435 houses, with a population of 6,781 souls consisting chiefly of Rajputs, but with a few Baniahs, Mahomedans, Boras, Jains, Chamars and Kumars, and a few Bhils who live on the outskirts.

The following villages are the residences of first and second class Thakurs:—

Bechiwara Lat. 23° 47′, Long. 73° 34′, population 421. This village is also a camping place for troops. The main road from Kherwára to Ahmedabad passes by it.

Mando Lat. 23° 46′, Long. 73° 38′, population 992. There is a large tank at this place.

Peit Lat. 23° 32′, Long. 73° 49′, population 1,095. This is a large trading village, and is on the road from

Meghraj to the Baneshwar temple, where a fair is held.

Sabli Lat. 23° 52′, Long. 73° 37′, population 138.

Thakarda Lat. 23° 42′, Long. 74° 0′, population 1,137. This village is situated about a mile east of the high road from Dúngarpur to Bánswára.

Dhamod Lat. 23° 46′, Long. 73° 33′, population 159 (residence of 2nd class Thakur).

Nolsam Lat. 23° 50′, Long. 73° 37′, population 385 (residence of 2nd class Thakur). There is a very large tank here.

Ver Lat. 23° 41′, Long. 73° 37′, population 75 (residence of 2nd class Thakur).

Members of the present Maharawal's family reside at

Sisodh Lat. 23° 55′, Long. 73° 36′, population 281. On the high road from Kherwára to Ahmedabad.

Mandwa Lat. 23° 51′, Long. 73° 35′, population 79.

Oda Chota Lat. 23° 50′, Long. 73° 39′, population 201.

The other large villages are :—

Thana Lat. 23° 49′, Long. 73° 43′, population 792. On the high road from Dúngarpur to Ahmedabad a *thana* is located here.

Gámri (Dewar) Lat. 23° 55′, Long. 73° 38′, population 481.

Khera Lat. 23° 51′, Long. 73° 50′, population 330. On the high road from Dúngarpur to Salúmbar and Neemuch; has a large tank.

Hathai Lat. 23° 54′, Long. 73° 46′, population 552. On the high road from Dúngarpur to Salúmbar and Neemuch.

Gámri (Mára) Lat. 23° 46′, Long. 73° 40′, population 440. On the road from Dúngarpur to Meghraj. The inhabitants are mostly Banjaras. There are also several grain-sellers.

Obri Lat. 23° 39′, Long. 73° 56′, population 1,560.

Dewal Lat. 23° 50′, Long. 73° 40′, population 1,547, camping place between Dúngarpur and Kherwára; a *thana* located here.

Semarwára Lat. 23° 31′, Long. 73° 47′, population 852. A large trading village.

Kanba Lat. 23° 46′, Long. 73° 37′, population 415, situated on the road from Dúngarpur to Ahmedabad; a *thana* located here.

Ghatanogam Lat. 23° 35′, Long. 73° 57′, population 481; situated on the road from Meghraj to Baneshwar temple; a small outpost here.

Genji Lat. 23° 45′, Long. 73° 44′, population 526; a *thana* here.

Ganeshpur Lat. 23° 36′, Long. 73° 55′, population 353. There is a *thana* here.

Dhambora Lat. 23° 38′, Long. 73° 48′, population 942. A place of some local importance; several Brahmins reside here, and it has a *thana*.

Wasi Lat. 23° 54′, Long. 73° 51′, population 895.

Antri Lat. 23° 44′, Long. 73° 53′, population 219. On the main road from Bánswára to Dúngarpur camping place and *thana*.

Punali Lat. 23° 50′, Long. 73° 57′, population 615. A small outpost stationed here.

Warda Lat. 23° 44′, Long. 73° 56′, population 829. On the main road from Bánswára to Dúngarpur.

Towns and cities in Idar State, Mahi-Kantha Agency, Bombay Presidency.

The chief place of importance in the season's work is Meghraj Lat. 23° 30′, Long. 73° 33′, population 1,247; contains a large bazaar, a *thana*, a school and post-box, and is on the high road from Modassa (Ahmednagar district) to Baneshwar temple another road from here branches off to Dúngarpur.

The other large villages are :—

Ger Lat. 23° 32′, Long. 73° 31′, population 432. *The residence of a 1st class Thakur.*

Mori Lat. 23° 35′, Long. 73° 39′, population 397. *The residence of a 1st class Thakur.*

Kantharia Lat. 23° 41′, Long. 73° 35′, population 366.

Kunol Lat. 23° 35′, Long. 73° 31′, population 586.

Panchal Lat. 23° 35′, Long. 73° 34′, population 466.

Waluna Lat. 23° 32′, Long. 73° 32′, population 492.

The principal roads met with are :—

Roads.

(1) From Bánswára to Dúngarpur and thence on to Kherwára; (2) from Kherwára to Oodeypore, (3) from Kherwára to Ahmedabad; (4) from Kherwára to Idar; (5) from Dúngarpur to Ahmedabad joining (3) at Buhiwara; and (6) from Meghraj to Sagwara and Baneshwar temple. All the above are passable for wheeled conveyance, but none are metalled. The other roads over which laden camels can be taken are :—

From Dúngarpur to Salúmbar and Neemuch.

Ditto to Meghraj.

Ditto to Kalianpur, which joins the Oodeypore road at Rakhabdeo.

From Dúngarpur to Konbai and Idar.
Ditto to Peit where it joins the road to Sagwara.
From Meghraj *viâ* Peit to Sagwara.
From Kherwára to Bhorai fort.

There are also numerous paths which connect the several villages and Bhil Pals. There is very little wheeled traffic, pack bullocks and donkeys being chiefly used: camel carriage was used by the survey party throughout the season, and no difficulty was found in moving about the country. During the time that the Baneshwar fair is held in February, carts are used extensively on the road from Meghraj to Sagwara by traders and others from Gujarát.

Rivers.

The Som river traverses the northern part of the work for a short distance and flows eastwards forming the boundary between Oodeypore and Dúngarpur. Its tributaries are the Ghorel, Sapin or Gangri, and Bhadesar, all small streams, but they contain a good supply of water all the year round.

The Moran takes its rise in sheet 58; its tributaries are the Sandri and Bhai. From the point of junction of the Sandri with the Moran there is always a plentiful supply of water in the bed of the latter, which is very stony in parts but the banks are not steep.

The Wátrak, which also takes its rise in sheet 58, flows in a south-westerly direction and enters Gujarát, where the banks become high and steep: the bed is sandy for the most part, and in the dry season the river is fordable everywhere.

Lakes and tanks.

There are no natural lakes in sheets 58 and 59, but several artificial ones exist. Those at Dúngarpur, Khera, Bhanda, Thana, Nolsam, Dhambora, Sital, and Peit are worth mentioning.

Inhabitants.

The inhabitants in Dúngarpur and Oodeypore are mostly Bhils. The leading Pals in Oodeypore along the border are the Valicha, Kanbai, and Bhorai; and in Dúngarpur the Padri, Bokla, and Boali. They are carefully watched by the outposts stationed at convenient centres by the two Durbars. In the interior of the Dúngarpur State, there are the Hirathu, Mando, Lembarwara, Gundwa and Kolkonda Pals, who with those previously mentioned claim to be the original possessors of the land; they live in a somewhat semi-independent state, and only a few of the Durbar officials are allowed to have access to their villages. They do not mix with the other inhabitants of the State, and are exempt from all menial work; the survey establishments were well treated by the Bhil community in the Dúngarpur State throughout the season, and although some uneasy feeling existed last season when the triangulation was advanced through the tract of country occupied by the Mando and Padir Pals, this season the same clans gave every aid to the plane-tablers.

While working in the Oodeypore State some sensational stories were circulated about the Survey establishment having come to weigh the married men and women, and that of those found of unequal weight there would be a redistribution, thus disturbing their marriage ties. Another was that the poles put up as signals to mark the trigonometrical stations were for the immolation of the men and women. This being brought to the notice of the Oodeypore Durbar, the Resident sent word that the stay of the Survey parties should be shortened as much as possible. Opportunely my camp had to go along the border country when these absurd stories were being circulated, and it being the time of the Holi festival the Bhils and their families were freely invited to the survey camp to convince them of the absurdity of these stories and were encouraged to dance and sing, and some of the men to shoot at a target with their bows and arrows which created great amusement. The Holi festival is observed by the Bhils for a period of 15 days, and during this time the women are allowed to go from place to place, and to the camps of officials, singing and dancing—levying a sort of black mail. Consequently large numbers of the Bhils, with their women and children, collected at my camp at different places of an evening, and after the usual festivities were always dismissed with a *douceur* which had the desired effect of promoting harmony, and for the remainder of the season the Bhils were on the best of terms with the Survey establishment.

On the northern portion of the Idar State, and along the western confines of the Dúngarpur State, there are some families of Bhils who have become "Bhagats," *i.e.*, they have given up drinking spirits and eating flesh; they are considered outcasts by the orthodox Bhil who revels in his drinking bouts, which occur unfortunately rather too frequently. A marriage, a death, or some religious ceremony is taken advantage of to bring together the families and friends of the interested parties, and then for two or three days nothing is thought of but drink and song in which the women join. During these gatherings some old family feud is revived and then there is fighting. Such a case happened while the survey operations were being carried on in the vicinity of Kherwára. The Bhils, greatly excited, collected in large numbers, men and women mustering about 2,000, and an affray ensued which lasted four days; the casualties were fortunately small, only some 6 or 7 Bhils killed, but among them a woman, who was accidentally shot by an arrow. The women who accompany the Bhils in a fighting expedition are generally unmarried, or those who have had no children; their mission is to take water to the disabled men irrespective of friends or foes, and they are always honourably treated while thus employed. The women, however, carry a sling and some stones for their own defence. At this time the Meywar Bhil Corps with its officers were at Oodeypore to be present at the ceremony of the installation of the Maharana, and the Bhils, no doubt taking advantage of this occurrence, could not resist the temptation of having one of their old feuds settled according to their own primitive customs. Sub-surveyors Shekh Oomar, Bapu Jadu, and Mohidin had

their camps not far from the scene of disturbance, but none of the Survey establishment were in any way molested. Some of the Bhils, however, pulled down the poles which were put up to mark the Survey stations.

The other inhabitants are Rajputs, Brahmins, a few Mahomedans, Oswalls, Banias, Patels and other agricultural classes. In several of the villages of Idar falling within the season's work there are some well-to-do families of 'Thakurlas;' they are a mixed race of Thakurs (Rajputs) and Bhils and form a community of their own, considering themselves much above the Bhils.

On the 30th March there was an eclipse of the moon, and my camp on that day happened to be at Warla (on the boundary of Oodeypore and Dúngarpur) which is encompassed by several large Bhil Pals. At about 9 o'clock at night the 'Kilki' or war assembly cry was sounded in one of the adjacent huts, and was repeated by all the houses in rotation. The 'Kilki' is a sort of jerky shrieky sound vibrated by the playing of the fingers on the mouth, and the peculiar noise extending for miles all round has a most fascinating effect. Within an hour the sounds gradually ceased, and then all was quiet for the rest of the night. The Bhils have some natural fear of impending harm when there is an eclipse or an earthquake.

Language. The language spoken in the Dúngarpur State is a mixture of Gujaráthi and Hindustani and is called Bágar.

Products, soil, &c. The products and soil have been described in the report of the previous year.

Temples. There are a few temples very picturesquely situated in the hills: some have been constructed by the Jains who spend a lot of money in the decorations of their temples. Those at Kherowli, Athor, Modar, and one or two others are resorted to by pilgrims, and have some local fame; at the foot of the hill on which the Kherowli temple stands, a rest-house for the convenience of the pilgrims is under construction by the Maharawal of Dúngarpur.

Fairs. About a mile to the south-west of the village of Rasta there is a sacred clump of trees on the right bank of the Dhora Nala where the idol Mahadeo is worshipped and where a fair is held annually; the offerings made by the pilgrims amount to a large sum of money, but since the site on which the fair is held is disputed, the collection has been interdicted pending the settlement of the dispute between the Durbars of Idar and Dúngarpur. Vast crowds of people from Gujarát pass along the high road leading through Kherwára (from Ahmedabad) to Rakabdeo temple which is about 10 miles to the north of Kherwára. For the safe escort of the pilgrims (consisting chiefly of women) Bhils are employed who can generally be trusted when payment is made for personal protection. Another fair is held for three days preceding the Holi festival on the banks of the Bhindra Nala between the villages of Naogaon and Rakhapur in a large tope of teak trees in the Idar State.

Notes on the Town of Bhínmál and surrounding country, by Mr. G. P. Tate, Assistant Surveyor, 2nd grade.

The town of Bhínmál, in latitude 25°-0′-27″ and longitude 75°-18′-4″, is built in an open cultivated plain between the Sagi and Sakhli rivers, and until a year ago was the place of greatest importance in the pargana.

In 1883 Sálam Singh, Rana of Lohiána, who had been a prisoner at large in Jodhpore, broke his parole and made his way to the Sunda hills, which had been the refuge of his ancestors from time immemorial and where he intended to muster his adherents and make a stand. Owing to the energy of the Jodhpore Durbar, Sálam Singh's intentions were frustrated, and those of the neighbouring Chiefs who were well disposed towards him had to furnish guarantees of their future good behaviour, and were overawed by the presence of a force of 2,500 men commanded by His Highness Maharajah Jaswant Singh, G.C.S.I., in person. The village of Lohiána was destroyed, and a stone fort built in a good position about half a mile to the north-east, which is capable of holding a garrison of 200 men and contains the *kacheri* and residence of the Hákim of the pargana. It has been called Jaswantpura. A Post office has been opened here, and it is hoped that in time a town will spring up under the walls of the fort. The transfer of the official head-quarters of the pargana to Jaswantpura has affected the prestige of Bhínmál; but as the latter stands on the ancient trade route between Gujarát and Marwar it will long hold its own against its new rival.

Bhínmál is a well-built town, almost entirely consisting of brick houses; and although there is the usual fringe of huts belonging to the lower classes and herdsmen, the interior of the town is fairly well kept. On the outskirts of the town to the north is the Jeypokh tank, a fine sheet of water; and there are a number of others in the vicinity.

To the west of Bhínmál, and distant about 1½ miles, rises an isolated conical hill, about 400 feet above the level of the surrounding country, and crowned by two Hindu temples built on a high square plinth, which viewed from below resembles a small castle. At its base is a low arch, the top of which is on a level with the surface of the plinth above which the temples rise to the height of about 10 feet. They are reached by a flight of stone steps, 230 in number, built along the south face of the hill, and beyond being massively built, and their antiquity, there is nothing interesting about them. On the north-western face of the hill and about 50 feet lower than the temples is a reservoir capable of holding about

8,000 cubic feet of water, which however is entirely dependent on the rainfall for its supply. The hill of Bhínmál is visible for miles round and is a prominent landmark.

Within the town are three Jain temples. The two more important are dedicated to Parasnáth and Santnáth. On the outskirts of the town to the south and a few hundred yards from it is a small fortified enclosure containing several small but ancient temples as well as a reservoir, in which there is a small stagnant supply of water. Each side of the enclosure is about 100 feet long, and is flanked by a small circular bastion at each corner: the walls in the inside are about 10 feet in height, with a banquette running round the interior, and are pierced for musketry. The entrance is through an arched gate in the side nearest the town. Owing to the sand having drifted up against the works outside, they are not more than about 6 feet above the level of the ground. The enclosure is situated on a gentle rise and between the roads leading to Bargaon and Jaswantpura, the former about 100 and the latter about 150 yards distant.

North of this enclosure and just without the town is the ruin of an ancient palace; only a small portion is now left, barely enough to afford an indication as to its original extent or design as most of the materials have been carried off by the inhabitants of Bhínmál, and pillars belonging to this building, as well as slabs of stone, have been used to build a *bárádari* (summer house) on the banks of the Jeypokh tank. The style of architecture must have been very handsome, and some of the pillars are very elegant.

Bhínmál was at one time a fortified town, and four gates afforded means of ingress and egress. The gates were named as follows:—The Súraj Pol or eastern, the Gujarát or southern, the Sanchor or western, and the Jallor or northern gate, the last of which is the only one not in utter ruin.

The fortifications in this part of Rajputana are simple in style, but quite answer the purpose for which they were required. They comprise a deep ditch, and an earthen bank crested with a prickly-pear hedge, or even with a thick hedge of brambles. Small circular projections break the face of these lines and afford a slight amount of flank defence, and occasionally a detached hut or house in the village is utilized as a bastion. The gates are formed by a couple of heavy logs at either side of the entrance set upright, the space between being closed by a rude barred gate swinging on wooden sockets. The entrance is generally situated in a re-entering angle, and the approach commanded by one or more of the houses in the vicinity. In some cases there is a double ditch with a hedge in the middle. The trace of these lines is very irregular, being determined by the outline of the village required to be defended, and although rude in construction, they were quite strong enough to prevent their being carried by a rush, especially of horsemen; but owing to many years of peace it is only in a few villages that these works can be traced at the present day. In ancient times, according to tradition, Bhínmál was almost entirely inhabited by Bráhmins and is one of the large Bráhmin towns mentioned by Colonel Tod in his annals of Rajasthán as having existed in various parts of Marwar. At this time there is very little information obtainable as to these ancient colonists, and that information is so enveloped in the mists of tradition with its inevitable exaggerations, that it requires great caution and greater skill to detach the *nucleus* of fact from the *nebula* of fiction. Páli, to the north-east, was one of these ancient Bráhmin colonies, and Sanchor, south-west of Bhínmál, was another.

The destruction of Ajmere in 1193 by Shaháb-ud-dín broke up the great Chauhán clan of Rájputs: one section moved into Harowtee in Eastern Rajputana; another settled in Godwar, now a province of Marwar, and another under Gaj Singh seized on the hill of Jálor, and built the fort which still exists and which has given its name, Songarh, to the portion of the clan who settled there. Bhínmál formed part of the territory acquired by them, and was many years in their possession. The inhabitants were put to the sword by Berin Deo, fourth in descent from Gaj Singh. As usual, an excuse is invented by the bards, who are the repositories of all the traditions that have been handed down from ancient times, to palliate the crime.

Songarh was besieged in 1309 probably by Malik Kafur, the General of Ala-ud-dín, the Khilji King of Delhi, and after a long siege was taken and Berim Deo lost his life. The Chauháns held the country for generations, and conquered fresh lands to the south and south-west. Then the Rahtors of Marwar took first Jálor and then Bhínmál from the Chauháns, but their hold on Bhínmál was not left undisputed, as for very many years the Chauháns of Sirohee and Sanchor aided by the Kolis of Gujarát raided the country up to the walls of Jálor. Bhínmál was thus the most important and dangerous post on the southern frontier of Marwar, and was continually being lost and won by one or other of the contending parties, until the rapid increase in power of Marwar enabled the Rahtors to strengthen their hold on this part of their dominions. The cession of territory to the south by the Ráo of Sirohee to Maharaja Abhe Singh of Marwar carried the frontier of the latter State considerably beyond Bhínmál, and secured it from all possible danger of any organised attack.

The pargana of Bhínmál contains the important groups of hills known as the Sunda Bhakar and Dovia, and a number of other smaller masses, the most important of which is the Samaro hill and the Lakawa range. This country is inhabited by remnants of Rájput clans who were once very powerful, such as the Kaba Pramaras of Thar and Thalan; the Deval Parihan of Lohiána, Selwasan, Paran and other villages, while a few villages of Solankis to the south-west contain a fragment of that once great clan which reigned in Anhalwara Patan in Gujarát. Further south a section of Songarh Chauháns round Bargaon are included within the limits of the Bhínmál pargana, or as it is now called the Jaswantpura pargana. The conquest of this portion of the country belongs to the history of Sirohee, which remains to be mapped.

Suffice it to say that of the original possessors dispossessed by the Chauháns only the families exist in this part of the country. This part of the Bhínmál pargana is called the Kohistan of Marwar, and was for long in a very unsettled condition.

There is nothing manufactured in Bhínmál, but what is necessary for the use of the people roundabout, and the opening of the railway connecting Páli and Pachpadra will no doubt deprive Bhínmál of the greater part of its present trade.

Extract from the Narrative Report of MAJOR J. R. MCCULLAGH, R.E., *Deputy Superintendent Survey of India, in charge Mysore Topographical Survey,—Season 1884-85.*

The programme of operations included triangulation in Degree Sheet IX, traversing and levelling in and about Bangalore, the detail survey of Standard Sheets Nos. 54, 58, 62, 65, 67, 68, 69, and 70 on the 1″ scale, and also the detail survey of Bangalore Cantonment and City on the scale of 12 inches to the mile.

The country topographically surveyed this season presents two very distinct characteristics, for, while everywhere more or less hilly and undulating, the central and more eastern parts of the tract are fairly open, well cultivated, and populous; the western and southern portions are just the reverse, being densely forest-clad with few or absolutely no villages for miles and miles. The most striking topographical features which came under notice are the celebrated and historical hill fort of Gopalswamibetta, of which the garison now-a-days consists solely of an aged hermit with a boy attendant, and the extraordinary chasm sometimes styled "the Mysore ditch," which the Moyár river has formed for its channel and which constitutes the southern boundary of the Province.

The outturn of the season, though some 285 square miles less than what was estimated, is, I venture to think, as much as it was possible to accomplish. A few more square miles of topography on the 1″ scale might perhaps have been done, but no one sheet could have been completed, and it would have been at the expense of the 12″ survey and at great risk of failing to secure the completion of the latter. The plain and uncoloured maps of the season will at first sight, I fear, convey but a very poor idea of the difficulties which had to be encountered, but when more carefully looked into, it will be seen what an extensive area of State forests came within the sphere of operations, and it must also be borne in mind that the forest tract does not abruptly end with the forest boundaries but extends for miles and miles beyond, becoming very gradually less and less dense until the open is reached. In the forest it is needless to say that plane tabling by intersections was out of the question, and it is indeed fortunate that provision had been made, in the shape of theodolite traverse lines, for the detail surveyors to start and close their chaining on. Even in the more open parts of the country, where fixing could be made, chaining had very constantly and extensively to be resorted to. In the forest again, what with restricted communications, bad water, scanty supplies, the intense heat, the physical exertion required in continually cutting and clearing, as well as the unhealthiness of the tract and constant molestation by wild elephants and other animals, all combined to render the work exceedingly arduous and trying to all engaged thereon. In the case of the Bangalore Survey I may mention that your orders regarding the permanent marking of the stations of the special triangulation, also of the theodolite traverse stations have been carried out. The former, where, not on rock *in situ*, are marked with solid stone pillars firmly embedded in the ground with the usual circle and dot and the words "Survey of India" inscribed on the upper surface. The latter are marked also with solid stone pillars, but of a smaller size, with a circle and dot engraved thereon and buried flush or nearly flush with the ground. Regard has also been had to the permanency of the bench-marks determined by the spirit levelling, and where not on buildings, waste weirs of tanks, and such like sites, they are to be found on boundary pillars, pillars prepared for the purpose, or on our own pillars; in short, every care has been taken to render the work of lasting value.

Extract from the Narrative Report of Mr. H. Hörst, Deputy Superintendent Survey of India, in charge Burma Topographical Survey,—Season 1884-85.

The Local Government desired that the western side of the Pegu-Yoma Range should be completed before the eastern slopes are taken up, and this has been done up to the present time; but the Conservator of Forests, Pegu Circle, proposed that the survey should extend also east of the Yoma towards Toungoo. The proposal was sanctioned in August 1884.

At the request of the Chief Commissioner, British Burma, who wished to modify the system of survey with a view to economy, Mr. H. C. Hill, Conservator of Forests, Pegu Circle, and Mr. Hörst were directed to draw up a joint report. Both these officers were of opinion that the work on the scale of 4 inches = 1 mile could not be further generalized without effecting the utility of the maps, and that the annual out-turn, with the party at its present strength, could not reasonably be expected to exceed 300 square miles, exclusive of the tracts bordering the reserves to be surveyed on the scale of 2 inches = 1 mile.

The chief difficulties the triangulator has to contend against are the dense forest and the want of means of communication. To select a station he must make a clearing, as the trees are so high that he is unable to construct a *machán*, or scaffolding, without risk of breaking

his neck. Then, when he happens to spot some suitable points for stations, he can get no guides to take him to them, and on descending from the hill he had selected he loses sight of all points to which he has taken rays, and plods wearily along until he reaches a peak at which he has a repetition of the same difficulties. The Yoma generally affords suitable points, but the low country, which mostly lies hidden by the parallel ranges close to the main ridge, presents great difficulties. Even without the forest the progress would be slow compared with that in most districts in India, as in addition to these drawbacks, for two months the whole country is covered with a dense haze during which it is impossible to take observations, or even to reconnoitre.

The principal streams, or *Chaungs*, met with this year are the Minhla, Gamon, Taung, Bawbin and Taungnyo, which take their rise in the Yoma and flow into the plains in a south-west direction. These Chaungs consist only of pools of water in the dry months, but during the rains are raging torrents and carry down all the logs cut by contractors to the timber-depôts at Rangoon, where they are auctioned off about twice a month. The principal reserves are named after the Chaungs, and those which came under survey are the Minhla, Gamon, Taung, Bawbin, Upper and Lower Pha-yagyi, Minbu and portions of the Taungnyo, Upper Zamayi, and Kun Chaung (assumed name, not demarcated). The two last-named reserves lie on the eastern slope of the Yoma in the Toungoo district.

Four large Karen areas came under survey on the western side of Yoma and portion of one to the east. As has been explained before, there is greater labour in surveying the Karen areas in consequence of their being thickly overgrown with scrub bamboo and *kaing* grass, than the reserved forests which are more open. In these Karen areas there are 15 *Tés* or homesteads, with an average of 20 men to each besides women and children, but beyond serving as guides after much persuasion, the men are averse to rendering any assistance.

The following are the principal pathways practicable to laden elephants:—

Se-ywa to Nga-to-Te.—Se-ywa to North Minhla Chaung, along Chaung for a considerable distance to within a mile of the summit of the Yoma ridge; then along ridge southwards for a mile, down Pye-me-zili Chaung, and thence to Nga-to-Te. Path good: 3 marches.

Waing to Aung-ban-te.—Waing to Pindaing 6 miles, fair; Pindaing to Taung Chaung trying; along parts of Taung and Motsama Chaungs—along ridge to the Yoma near Kywegya-daung—along Yoma northwards for a mile, then in an easterly direction to Aung-ban-Te *viâ* Chan Chaung and Gyi-thi-oga Taung. Very trying to laden elephants: 3 marches.

Bawbin to Zamayi Chaung.—Bawbin to Tonthe, then to and along Thayet Chaung to junction with Kyein Chaung, thence up hill crossing the Yoma south of Sanamong-taung, down part of Pon-na Chaung, along water shed of Kadin and Linthet Chaungs till it reaches the Zamayi or Pegu river. Path very good, known as the Kywe Lan, by which cattle from the Shwegyin and Toungoo districts are always brought: 4 marches.

Bawbin to Kyauk-pyu-te.—Follows the Bawbin Chaung for about ¾ mile, then ascends the ridge and keeps to it for several miles; crosses the Kyauk-pyu Chaung and keeps along easy country till the Kyauk-pyu Chaung is recrossed, after which it runs along the ridge up to Kyauk-pyu te. Distance about 15 miles, in parts trying for elephants but good on the whole. Too long for a single march in hot weather.

Waing (west of Yoma) to Phau-te (east of Yoma) viâ Kyauk-Chaung Te.—After leaving Waing follows course of Gamon Chaung for about 6 miles, when it leaves the stream owing to the bed being full of boulders, but re-enters further up and follows the Chaung till about half a mile from the Yoma, where it leaves the stream and ascending the hill at an easy gradient, crosses the ridge and descends gradually to Phau-Te. Distance 3 marches.

From Bawbin viâ Thou-the and Kyauk-pyu on west of Yoma to Aupong east of it.—From Thou-the to Kyauk-pyu the path is rough, from Kyauk-pyu it follows the course of the Kyauk-pyu Chaung till within half a mile of the Yoma which it ascends by an easy gradient attaining an elevation in that distance of 750 feet. To the east of the Yoma the fall is easy to Aupong. Distance Kyauk-pyu to Aupong 16 miles. From Bawbin to Aupong (whole distance) 3 marches.

Extracts from the Narrative Report of Major S. H. Cowan, Deputy Superintendent, in charge Basti Cadastral Party,—Season 1884-85.

Owing to the very late rains of 1884 the party did not take the field so early as usual.

The work of the cadastral camps was commenced strictly on the Benares system, except that there were no settlement *munsarims* to supervise the record-writing, but it was at once found that, if the Survey Department was to be responsible for the accuracy of the record, the *amins* who were doing *khanapuri*, and the testing officers, must have access to the village papers, which was forbidden in Benares. There the tenants were all ready to assert their rights, and the plan of leaving disputed entries blank was a sufficient security that no erroneous entries were made. In Basti it was quite different; occupancy tenants, with few exceptions, were ready to say exactly as the zamindars wished, that their fields had only been held for three, four or five years; the distinction between *sir* and *khudkasht* was not known, so that all fields cultivated by the zamindars were called *sir*: the existence of non-resident tenants was concealed and their attendance at *khanapuri* prevented in order that the zamindar might have their fields entered as being in his own cultivation; the patwaris' old circles had just been broken up, and new circles

assigned to them, and many of the patwaris were new men, having no personal acquaintance with zamindars or tenants, and the verbal statements of most of them with regard to *sir* rights, or rights of occupancy, were unreliable; so that it was clearly impossible to write even a tolerably accurate record upon the mere statements of the persons interested. The village papers, of course, were not always reliable either, but they furnished a check on verbal statements, and, as there is no other record to refer to, entries made according to them must, as a rule, be upheld by the Revenue Courts. It was therefore arranged with the Settlement Officer that the survey *amins* should be allowed access to the village papers, and further (No. 661, dated 31st October, and S. O.s No, $\frac{100}{1-13}$ of 4th November) that the patwaris should supply the *amins* with lists of tenants with and without occupancy rights, and of zamindars cultivating holdings. The Settlement Officer considered that these lists "will probably be of some use in preventing such wholesale false entries as occurred last year, though they cannot take the place of a patient comparison of the old and new maps field by field, and of the interests in each field." These lists, however, had not been prepared in advance, and very few of them were at any time forthcoming; which was fortunate, for the *khanapuri* had hardly commenced before cases came to light showing that no reliance could be placed on statements prepared by the patwaris under immediate prospect of settlement operations. Their papers of the previous year were therefore taken for reference, and it was only by a comparison of the entries in them with the verbal account given on the spot of the facts of ownership and tenancy of each field, and insisting on explanation of discrepancies, that the record could be written with any confidence.

More than this, however, was found to be necessary as soon as it had been decided (after Mr. Hooper took charge of the settlement office) that no entries should be left blank, for often the patwaris' papers of the previous year did not show whether a tenant had a right of occupancy or not, and there was generally nothing in them to distinguish *sir* from *khudkasht* fields. In order to write up doubtful or disputed entries with a reasonable prospect of making them correct, reference to the papers of 12 years ago, and sometimes to papers of intermediate years also, was unavoidable. The Collector, Mr. Powlett, at first demurred to allowing the old papers to leave his record-room (Settlement Officer's No. 173, dated 25th November), but their issue to the *amins* began in December.

The delay entailed by these references to old papers was very great; first, there was the difficulty of discovering the old number of the field under record; this was done sometimes by comparing the new map with the old, and when, owing to the inaccuracy of the old map or changes in the field boundaries, this was impossible, by tracing the number the patwari had given it last year by means of the tenant's name. Often one old number was found divided into many, sometimes 20, 30, or even 50 new fields, and often one new field included fragments of several old fields.

The old number found, there followed the reference to last year's papers by a patwari not used to be hurried, and often another reference to the *jamabandi* of 12 years ago; as the fields in this were not arranged serially, each cultivator's fields of one tenure being grouped together, the whole document was sometimes gone over once or twice before the number wanted was found. It was evident that without abstracts arranged serially and showing briefly in one line the name of the cultivator of each field last year and 12 years ago, the record writing would get on very slowly indeed.

The patwaris of all the circles when work had not been commenced were called in to the settlement office and survey camps, and made to prepare these abstracts in the following form:—

Old Serial Number of Field.	By whom cultivated.		
	At last settlement.	Twelve years ago.	Last year.

and most of the work done from February, and afterwards had the advantage of these abstracts.

Even with the abstracts (*intikhab*) the work did not progress so fast as was desirable, and the Settlement Officer drew up a new set of rules, which was issued on 18th February, with the object of reducing the number of references to old papers. This object was not attained, and there can be no question that in the absence of honest capable patwaris, thoroughly acquainted with the people and lands within their circles, it is impossible to write a record worth having, without constant reference to the village papers.

Under the new rules now in the press it is required that all names of new tenants should be written in red in the *khasra*, so that reference to the papers of last year will be necessary in every case, but the present Settlement Officer, Mr. Hooper, has had abstracts (*intikhab*) prepared during the recess for all the villages in this season's work, so that all that can be done to expedite the *khanapuri* has been done.

The following table shows the monthly out-turn and rates of survey and *khanapuri* during the field season: it will be seen that the rate of *khanapuri* fluctuated with each change of system:—

Months.	Amin's days.		Out-turn.			Out-turn per day.		
	Survey.	Khanapuri.	Survey.		Khanapuri.	Fields surveyed.	Acres surveyed.	Fields khanapuri.
			Fields.	Acres.	Fields.			
November	3,561	1,279	153,396	63,346	83,368	43	18	65
December	3,440	2,523	175,925	69,001	149,018	51	20	59
January	3,513	3,194	175,214	66,448	132,075	50	19	41
February	3,034	3,692	166,491	65,456	162,119	55	21	44
March	2,630	3,601	148,376	59,270	147,008	56	23	41
April	3,299	3,782	208,458	78,556	209,665	63	24	55
May	1,030	3,648	74,367	14,968	213,785	72	15	59
June	7	93	...	...	5,189	...	..	...
Total	20,514	21,812	1,102,227	417,045	1,102,226	54	20	51

Of *tahsil* Harraiya in which operations were commenced there remain only 89 villages: of all the rest the papers have been made over ready for attestation, and also upwards of 200 villages of the next *tahsil* (Basti).

The strength of the Nagri records and statistics establishment has been—

in December	6 men.	in May	360 men.
„ January	437 „	„ June	284 „
„ February	492 „	„ July	287 „
„ March	292 „	„ August	293 „
„ April	347 „	„ September	285 „

The raising and supervision of this establishment during the field season was a heavy additional anxiety and responsibility for the officers in charge of cadastral camps, as each camp had its own statistics office.

Extracts from the Narrative Report of Major J. E. Sandeman, S.C., *Deputy Superintendent, Survey of India, in charge of the Gorakhpur Cadastral Survey,—Season 1884-85.*

Deputy Superintendent's opinion as to how to effect economy.

The new modifications in procedure during 1884-85 have made a better division of labour between the Settlement and Survey Departments, but there is still much to be done, in my opinion, if economy is to be studied.

The assessment of the Government demands is the personal work of the Settlement Officer.

Let the rough *kissakashi* or share list of proprietors be revised by the *kanungos* and *patwaris*. In our new hand-book the *amin* is bound to bring to immediate notice all mistakes in the *khewat*, and we can always call in the assistance of the Settlement Department when required.

Let the demarcation be renewed through the same (district) agency, instead of employing a special staff at great cost as at present; we would bring all disputes to notice and furnish maps of the ground to the Deputy Collector before he undertakes their settlement.

Let the preliminary attestation be effected through the agency of the *patwari* in the survey camp; this is merely reading out the areas and recording any fresh disputes that may arise.

The final or Deputy Collector's attestation would only then remain.

Finally, let the fairing of the *jamabandis* be done (partly through the agency of the *patwaris*) in the Survey Office.

In this way alone, as it seems to me, will the new combined system of Survey and Settlement be such a success financially as it is quite capable of being made. But these are mere suggestions; the Settlement Officer is the best judge.

Recommendations of Settlement Officers that the rough *jamabandis* be made in the Survey Office.

I believe both the Settlement Officers of Gorakhpur and Basti have recommended that the *jamabandi* slips should in future be copied into the *jamabandi* form before attestation, in the Survey Office. They have also recommended that the Nagri *khasra* should not be written up as a duplicate at time of *khanapuri*, but prepared afterwards by the *patwari* from the corrected and attested *jamabandi*.

These reforms alone will cause a great saving, and there can be no doubt the work will be better done. Further experience may shew that other reforms are advisable, for there is so much to learn that still our work can only be said to be in an experimental stage.

The office under Mr. T. Shaw, Assistant Surveyor at Gorakhpur.

The plan of leaving an assistant at Gorakhpur to bring up the completion of the *terijs* and statistics for the Settlement Officer, while all the original 16″ field maps, area computations, Urdu *khasras*, all the traverse computations and the 2″ sheets are taken to recess quarters at Naini Tal, was again adopted with success. Mr. Shaw, Assistant Surveyor, who once more volunteered to remain at Gorakhpur, has been in charge of the office there. I am thoroughly satisfied with the manner in which Mr. Shaw has superintended the work there.

Statistics of the Bánsgaon *tahsil*, Gorakhpur district.

The Bánsgaon *tahsil* contains the following parganas and *tappas*:—

Serial No.	Names of Tappas.	Parganas.
1	Haveli	Unaula.
2	Bankata	
3	Mahsan	
4	Kuswasi	Bhawapár.
5	achisi	
6	Gurmhi	
7	Kota	
8	Gagha	
9	Pali	Dhuriapár.
10	Tiar	
11	Gaur	
12	Dandi	
13	Narre	
14	Kolwara	
15	Athaisi	
16	Majhuri	
17	Kutahan	
18	Barhaj	
19	Chandpur	
20	Kurmant	
21	Babhnauli	
22	Shahpur	
23	Bhadar	
24	Parsi	
25	Usri	
26	Thati	
27	Nakauri	
28	Chorar	
29	Haveli	
30	Bankat	
31	Ratanpur	
32	Belghat	
33	Majhauli	Chillapár.
34	Semra	
35	Haveli	
36	Kasba	
37	Sikandarpur	

Divisions of the *tahsil*

Number and size of *mouzas*.

There are 2,072 separate villages (*mouzas*) in the *tahsil*, their average size being 187·45 acres.

The following is a statement in detail of the proprietary tenures under which they are held:—

Zamindari.	Bilijmal.	Pattidari namukammal.	Pattidari mukammal.	Total.
162	586	1,304	20	2,072

Area of *tahsil*.

The area of the *tahsil* is 387,542·03 acres or 605·53 square miles. This is not the final area, as the boundary between Azamgarh and Gorakhpur is still undetermined in one place.

Sizes of bighas.

The sizes of the pargana bighas are as follows:—

Parganas Chillapár, Anaula and Dhuriapár (cis-Gogra) 1-10·17 = 1 acre or 1 bigha = 3,137 square yards.

Pargana Bhawapár and Dhuriapár (trans-Gogra) 12 biswas of above or 1 bigha = 1,882·62 square yards.

In Deoria *tahsil* the pargana bigha = 3,306 square yards.

The following table gives the amount of wet and dry cultivation :—

Irrigated and dry cultivation.

Irrigated.		Total.	Dry.
From wells.	Other sources.		
Acres.			
32,290	93,621	125,911	138,920·06

To contrast the totals with those of the Deoria *tahsil* surveyed in 1883-84.

In it the area irrigated from wells was 124,036 acres and from other sources 29,705 acres and the dry cultivation was 135,976 acres. The condition of the two *tahsils* is thus very different as regards the sources for irrigation. In Deoria the irrigation is chiefly from wells, and in Bánsgaon to a much larger extent from *tals* or lakes.

The areas in Bánsgaon and Deoria cultivated by proprietors and tenants are contrasted below :—

Proprietors and tenants' land.

	Sir and Khudkasht.	Percentage of Total.	Tenants' land.	Percentage of Total.
In Bánsgaon .	101,494	38	163,338	61
Deoria . .	92,650	32	189,949	67

The numbers of occupancy tenants and tenants-at-will and the areas cultivated by each in the two *tahsils* are contrasted below :—

Occupancy tenants and tenants-at-will and rent-free tenants.

	Occupancy tenants.		Tenants-at-will.	
	No.	Acres.	No.	Acres.
In Bánsgaon .	73,682	88,423	86,782	67,348
In Deoria . .	103,312	126,977	82,744	62,973

In Bánsgaon the occupancy tenants are 46 per cent. and the tenants-at-will are 54 per cent. of the whole.

In Deoria the former are 55 per cent. and the latter 45 per cent. of the whole.

The rent-free tenants in Bánsgaon number 4,850 and cultivate 7,917 acres. The average size of a holding is :—

Size of holdings.

	Occupancy tenant.	Tenants-at-will.
	Acres.	Acres.
In Bánsgaon	1·20	0·77
In Deoria	1·22	0·76

The areas of cultivable and barren land in the two *tahsils* are as follows :—

Cultivable.

Cultivable and barren land.

	Fallow.	Groves.	Grass.	Bush.	Total.
In Bánsgaon .	29,297	15,007	637	9,648	54,589
In Deoria . .	27,220	12,893	1,629	2,081	44,023

Barren.

	Village sites.	Covered with water.	Otherwise barren.	Total.
In Bánsgaon .	7,081	33,823	27,218	68,122
In Deoria .	6,739	22,436	13,246	42,421

The cultivated areas under the various natural soils are as follows:—

Soils.

Natural soils.	Bánsgaon.	Deoria.
Doras, loam	175,602	170,260
Matiyar, clay	34,487	44,647
Balua, sand	14,388	31,510
Bhat, a calcareous soil	9	34,287
Kachhar, new alluvion	40,345	8,414
Total cultivation	264,831	289,118

The conventional tracts into which the lands of a *mouza* are divided for assessment purposes contain the following areas:—

	In Bánsgaon.	In Deoria.
Goend (home lands)	42,496	56,799
Miyana (middle tract)	79,126	119,038
Palo (outlying tract)	143,208	113,281
TOTAL	264,831	289,118

The following are some agricultural statistics—

Agricultural statistics.

	Wells.				Ploughs.							
	Built before last 10 years.	Built during last 10 years.	Total.	Earthen.	2-bullock.	1-bullock.	Total.	Plough cattle.	Other cattle.	Sheep and goats.	Houses.	Inhabited sites.
In Bánsgaon	4,892	1,466	6,358	3,074	43,919	683	44,602	91,944	141,032	53,059	1,583	4,454
In Deoria	7,339	2,124	9,482	8,936	41,949	79	42,028	86,168	128,675	62,741	1,962	2,980

In Deoria the village sites were 5 to the square mile.

In Bánsgaon they are 7 per square mile.

The following are the areas under some of the principal crops in the two harvests, the areas in Deoria are given alongside for comparison.

Kharif.

	In Bánsgaon.	In Deoria.
Dhan (Bhadain)	9,334	29,120
Dhan (Aghani)	38,868	22,698
Makai	2,326	9,862
Kodo	15,197	50,762
Arhar	48,797	27,424
Other crops	14,381	10,444
Total of food crops	128,903	150,310
Sugarcane	2,484	12,895
Cotton	737	4,817
Indigo	448	2,569
Other crops	1,468	2,630
Total of non-food crops in the kharif	5,137	22,911
GRAND TOTAL OF KHARIF	134,040	173,221

Rabi Harvest.

	In Bánsgaon.	In Deoria.
Wheat	23,748	8,398
Barley	54,225	70,542
Gojai	45,855	33,660
Gram	10,278	2,894
Kerao (peas)	21,561	27,947
Potatoes	238	373
Other food crops	14,935	3,407
Total food crops	170,840	147,223
Opium	3,732	6,594
Tobacco	132	120
Tisi	13,344	4,881
Other non-food crops	1,644	1,034
Total non-food crops in rabi	18,852	11,929
Total of rabi harvest	189,692	159,152
Total food crops in the year	299,743	297,533
Total non-food crops in the year	23,989	34,840
Total cropped area	323,732	332,373

The following is a statement of cultivators giving the numbers of the various castes and the areas cultivated by each.

Castes.	In Bánsgaon.		In Deoria.	
	No.	Areas.	No.	Areas.
		Acres.		Acres.
Mahomedans	2,686	5,015	3,483	6,033
Brahmans	42,784	73,822	27,573	75,503
Rajputs, Thakurs or Chatris	19,573	47,640	12,452	44,793
Banyas	2,605	3,284	2,453	3,840
Kayaths	3,132	5,932	2,966	8,335
Chamars or Dusadhs	10,876	13,906	8,693	14,889
Ahir	18,716	34,184	16,574	35,966
Koeri	7,003	11,787	13,502	30,856
Kurmi	9,720	18,106	4,260	12,094
Mallah, Kahar or Gondh	6,318	7,945	6,206	8,972
Other castes	32,642	43,179	26,415	45,699
Christians	8	42	78	2,137
Total cultivators	156,063	264,838	124,645	289,117

It should be stated that the above statistics are those extracted before the Settlement Officer's attestation and inspection of villages and many of them are liable to slight alteration. The statistics of Deoria are given alongside so that the material state of the two *tahsils* is contrasted at a glance.

It is my intention with your approval to commence during the next recess a series of maps on a small scale of the district, illustrative of the soils, irrigation, tenures, crops, density and castes of cultivators.

These I think would be of great use to the Agricultural Department and to district officers.

Copy of letter No. 518, dated 6th January 1886, from the Settlement Officer, Gorakhpur, to the Deputy Superintendent of Survey, in charge Gorakhpur Party.

With reference to your letter No. 316, dated 10th December, I have the honour to forward a statement showing the actual cost of settlement work in Deoria *tahsil*.

I have divided the cost into four main heads :—

		Per Square Mile.
	R a. p.	R a. p.
1. Operations preliminary to attestation	17,050 1 5	29 2 3
2. Attestation	30,089 6 2	51 7 1
3. Fairing and completing records	38,012 10 8	64 15 9
	85,152 2 3	145 9 1
4. Assessment and subsequent operations	54,797 4 2	93 10 8
TOTAL	1,39,949 6 5	239 3 9

The first three heads comprise all charges properly debitable to the preparation of the record-of-rights. The account for binding has not yet been wound up, but the addition of ₹400 or ₹500 on this account will not materially affect the total. All other record work, except binding, has been completed and paid for.

In the operations preliminary to assessment, I have included the pay of the Deputy Collector and his establishment, who was deputed on 15th February 1883 to settle boundaries and prepare *khewats* in advance for the survey. I have also charged the pay of the Deputy Collectors and their *munsarims* up to 1st April 1884 to this head. From April 1884 the work of attestation began and continued till 1st January 1885.

The fourth head includes the pay of the Settlement Officer from November 1883 to 30th September 1885. As a matter of fact I did not commence the inspection and assessment of Deoria till November 1884. It also includes the pay of the fixed establishment attached to the Court of the Settlement Officer and of the English office and establishment for preparing village statistics. The assessment of Deoria was submitted to the Board in September 1885, and there will be some further charges for distribution of the revenue. The calculations, however, have all been worked out, and what remains to be done will be done mainly through kanungos and patwaris.

The Bánsgaon attestation was finished during the Christmas holidays, and in a few days I shall be able to give you the total cost of attestation. The preliminary work in Bánsgaon was very heavy. The boundary disputes were of exceptional difficulty, and occupied two Deputy Collectors as long as the Survey was in the field. The cost was ₹30,579-4-9, or ₹50-0-9 per square mile; such a heavy item cannot occur again. In the northern *tahsils* boundary disputes give little trouble, and the preparation of the *khewat* is simple.

Copy of letter No. 10, dated Camp viâ *Gorakhpur, 11th January 1886, from Major J. E. Sandeman, Deputy Superintendent, in charge Gorakhpur Party, to the Deputy Surveyor-General, in charge Revenue Surveys.*

* No. 518—I.F.-15, dated 6th January 1886.

In reply to your No. 166 R., dated 4th December 1885, I have the honour to enclose a copy of a letter*, with statement of cost for the Deoria *tahsil*, received from the Settlement Officer.

2. You will perceive that the cost of his portion of the joint operations is so far very heavy. He gives explanations showing the high rates to have been in a measure exceptional; but as the cost of the North-Western Provinces system, in the success of which I have taken considerable personal interest, is about to be brought into comparison with that of similar work in other provinces, I would beg to offer a few remarks which I trust may be taken into consideration when a comparison is made.

(1) There are many local causes which have tended to raise the cost so far. The Deoria and Bánsgaon *tahsils* in which we have been working are exceptional, for even the North-Western Provinces, owing to the prevalence of complicated tenures, small fields, and disputes due to the existing maps being of a very inferior description.

(2) If the *Survey* charges under different heads are examined, it will be seen that the various descriptions of work could not have been done at a diminished cost under any other supervising agency; if the settlement charges are therefore as high as they are, when so much has been supplied, what would they have been without our aid?

3. If a comparison is especially made between the North-Western Provinces system and that of the Punjab, for example, the following differences in procedure should be kept in mind.

Here the Settlement Officer has spent ₹17,050 and employed a special staff for operations preliminary to survey; in the Punjab, the same work is done through the agency of the district staff and costs nothing.

Here the attestation has cost ₹30,089, and the papers have been attested through the agency of special establishments of (1) *muharrirs*, (2) *munsarims*; in the Punjab the preliminary attestation is carried out through the agency of the district staff.

Here a sum of ₹38,012 has been spent on fairing the records; whereas in the Punjab there is no fairing (*vide* paragraph 1 of new Punjab Manual), which runs:—"There will be no fairing of any kind. Every paper will be filed in original as it is written."

Here the assessment charges are very high, the Settlement Officer is very highly paid, and moreover he has explained why hitherto these charges have been abnormally high.

4. I hope it will be acknowledged therefore that it is not due to the employment of the *Survey Department* that the charges of the joint operations have been so high; and, as a proof of this, I will quote the costs of certain settlements in these provinces with which the Survey had no connection; and these, it should be remembered, do not include charges for traversing and stone-embedding. For instance:—

	₹		₹
Shâhjahánpur . .	336 per square mile.	Fatehpur . . .	349 per square mile.
Farrukhabad . .	296 „	Partabgarh . .	345 „
Allahabad . .	391 „	Lucknow . . .	532 „
Cawnpore . . .	300 „	Faizabad . . .	520 „

5. With particular reference to paragraph 28 of the Government Resolution on the Report of the operations of the Survey Department for 1883-84, I have, with all due deference, the following observations to offer:—

(1) I think that the Government is wrong in judging that the employment of the Survey Department raises the cost of work. On the contrary, other things being equal, its employment will probably reduce expense; for instance, including all European supervision, —

	R	a.	p.	
our field survey last season cost	0	0	10	per field
our records	0	0	5	„

it is the cost *per field* that should be taken as the test after all, and not the mileage; even the initial cost of work of an inferior description, using patwari agency under Settlement Officer's supervision, will be hardly less than this. And as to economy in the long run, there can be no comparison. Patwaris need not the same education if professional maps are supplied to them. The latter may be allowed to fall into arrears for years, and can then easily be brought up to date for assessment purposes. As an example the other way, every province in the Presidency is now under re-survey owing to defective maps at the last settlement; whereas all the districts in which professional maps have been made in the North-Western Provinces are done once for all time.

(2) The Government is quite right in thinking that the North-Western Provinces system requires to be combined "with the more liberal employment of the village staff," and then only can a fair comparison be instituted with work in other provinces. Although the patwaris should be instructed in surveying, I would not employ them to such an extent as to vitiate the accuracy of the original maps, but would utilize them in other ways to reduce cost. Through their agency (1) the work preliminary to survey, (2) the preliminary attestation, and (3) the fairing, in part or whole, might be done, and then there will be no fear as to a comparison of even the initial cost with any other system.

6. Our Settlement Officer has had much experience, and he is the best judge of what constitutes an adequate attestation, and of how to deal with the complicated tenures and other difficulties we have as yet had to encounter; but that his views are tending towards the more liberal employment of the district staff and consequent lessening of the first cost of the operations will be apparent from the following extract from a recent order of the 7th instant:

Writing of the Silhat pargana, "*muharrirs* are necessary here as the tenures are complicated and as difficult as in Bánsgaon." "For next year's work no *muharrirs* will be employed. Disputes are few, and there are few or no *pattidari* tenures in Hata and Padrauna." "The work of explaining the entries to the tenants and making out a Hindi *jird Ikhtilaf* will be made over to the patwaris." "The supervisor kanungos will be employed as *munsarims* during the attestation."

I believe the demarcation of boundaries is now being carried out through the agency of the district staff also. And I would suggest that all fairing work, which cannot be done by this means, should be done in the Survey Office, which would tend to great economy, as the Settlement Officer has not the same skilled agency at his disposal for making totals, &c., as is always available in the Survey Office.

7. The adoption of the new economical system has been altogether on one side yet, and what I have tried to explain above is, briefly, that it is necessary for both the Departments engaged on the joint operations to do so before favourable results can be obtained.

Extract from letter No. 540, dated 10th February 1886, from the Settlement Officer, Gorakhpur, to the Commissioner of Benares Division.

The question asked in G. O. No. $\frac{2138}{1-455}$, dated 17th December, is whether a provincial staff could frame the records for the same sum, R60,000, as it now costs the survey for 750 square miles. I answer unhesitatingly in the negative. It is difficult to show exactly, or even roughly, how much greater the cost would be. The estimate has to be framed not upon our experience in Gorakhpur, but by supposing that we were working on a totally different system. The settlement charges as we now work may be divided under four heads:—

I.—Operations preliminary to attestation, *viz.*, preparation of the *khewat*, decision of boundary disputes, and assistance to the Survey.

II.—Attestation.

III.—Fairing the attested records.

IV.—Assessment and subsequent operations, including the distribution of the new assessments.

If we undertook the *khanapuri* and statistics now done by the survey, we should not be relieved of any expense under those four heads. In the first two seasons some settlement *munsarims* were employed with the survey camps in *khanapuri*. But very few were employed last year, and this season none have been employed. The survey *munsarims* are now thoroughly

competent, and the cost under the first head has been reduced from R17,000 in Deoria to about half in Hata and Padrauna.

The Settlement staff consists of a Settlement Officer, an Assistant Settlement Officer, and four Deputy Collectors. Our time is completely taken up by attestation and assessment work, and we could not work at the rate at which we now work if we devoted any of our time to supervision of *khanapuri* and the preparation of statistics. Either much less area would be completed, or it would be necessary to increase the staff by at least two Deputy Collectors. Nor would it be possible for a single Settlement Officer, even with an assistant, to supervise the preparation of the record in one part of the district and to inspect villages and assess in another part. At present I am relieved from the whole responsibility of the initial record. Our procedure is settled, and although during the first season Major Sandeman and I had many anxious consultations, yet now the entire control of the work is practically in his hands. In short, during the months from November to April inclusive, Major Sandeman's time is almost completely taken up by what are properly the duties of a Revenue Officer, moving about the *tahsil*, hearing complaints, answering references, and seeing generally that the work is kept up to the required standard. In fact, during the cold weather he is a Settlement Officer, and during the recess is a Survey Officer.

It has been conclusively proved in other districts that a field survey, unless accompanied by the preparation of a record, is worthless. The people will not come out of their villages to point out their fields as long as they see that the *amin* is only drawing lines on paper. When they know that their rights are being recorded they will come. If we took a map and a skeleton *khasra* from the survey, we should, in order to get a correct record, be obliged to alter about half the field boundaries. I saw a great deal of this in Banda, where the lists of corrections were often so long as practically to become a fresh field survey. If I undertook the *khanapuri*, I would have to employ not only a staff of *muharrirs* to make entries, but a staff of *amins* to make corrections of field boundaries. Granting that Major Sandeman could do the same area with fewer *amins* if he did not prepare the record, yet *amins* would be required for the record, and the cost of the *muharrirs* employed would be a charge in excess of the present charge. If the Survey did not prepare the record, they would employ fewer *munsarims*, but the Settlement would have to employ just as many to look after its *muharrirs*.

The great gain of the present system is that the survey is made and the record is prepared, and attested in a single year. If the Settlement attempted the initial preparation of the record, we could not get it attested within the year. The enormous advantage of attesting the record for the same year as that of survey is often not appreciated. Where the record is not attested for the year of survey, a separate staff has to be maintained to keep the record up to date. If even one year elapses between survey and attestation, the changes which take place by deaths, sales, mortgages, and evictions of tenants, add most materially to the labour and cost of attestation. Under the present system, the Survey takes the field in 1292 Fasli, and the patwaris can prepare their annual papers for 1293 on the new record.

In the matter of statistics again, while I do not think I could work so cheaply as the Survey, I am clearly of opinion that the figures I should obtain would not be so trustworthy. We command at present the services of a permanent staff,—men who have all their service been habituated to the manipulation of figures. My establishment must necessarily consist of men, taken more or less at haphazard from the candidates of the province,—men who perhaps for years have not done any work and whose faculties are rusty from disuse. I attach the greatest importance to the checks applied by the camp officers, and their permanent staff. They can do this work better than any Deputy Collectors to whom it could be entrusted.

The only flaw in our present procedure, as far as I can see, is that the statistics are made out on the survey record and not on the attested record. This really does not affect soils, nor the crop statement, nor the statement of the caste of actual cultivators, nor irrigation statistics, nor any statistics of this kind. Attestation may change an occupancy tenant into a non-occupancy tenant, or *vice versâ*, or any record as tenants' land recorded as *sir*. After long discussions, however, we decided that statistics of tenures also should be given by the Survey, mainly because it costs nothing and because the Settlement Officer is often obliged to inspect villages before he can obtain the attested figures. The Survey makes out a *terij*, or list of holdings, for the record. This must be totalled to ensure that no fields have been omitted, and must be drawn out by tenures in the form of the *jamabandi*. It is as easy to total *sir*, *khud-kasht*, and occupancy land separately, as it is to total the whole in one lump. The assessment statement has columns for both the Survey figures of tenures and for the attested figures.

The Survey Officer will no doubt reply to the second question, as to whether his Department could get the survey work, pure and simple, done for R70 000; or if not, how much more would it cost than R70,000, how much less than R1,30,000? It is, I am aware, a favourite paradox of Major Sandeman's, that the *khanapuri* and statistics cost less than nothing, that is, that he has done the survey, compiled statistics, and prepared the record, for a less sum than survey, pure and simple, cost a few years ago; one thing is certain, that survey, pure and simple, is a clear waste of money; but supposing that the survey, pure and simple, could be done for R1,00,000 (thus giving a saving of R30,000), the records and statistics would cost the Settlement quite as much as they cost the Survey, or R60,000. To this would be added the pay of two Deputy Collectors, perhaps a large portion of the pay of a Settlement Officer, the pay of about 100 *muharrirs* for six months, and of *amins* to correct the field boundaries. There would also be the extra cost necessitated by not being able to attest the record for the year of survey.

Extract from the Narrative Report of LIEUTENANT-COLONEL F. CODDINGTON, *Deputy Superintendent, in charge of Punjab Party ;—season 1884-85.*

Simultaneously with the commencement of field work in Ferozepore, a beginning was made with the reduction of the patwari maps of Jullundur district, on the basis of the old traverse data of 1846-47, which was received from the Calcutta office. The first difficulty experienced was caused by the circumstance that each village had been traversed and surveyed as an isolated whole, hence large differences were unfortunately found to exist in many instances between the traverse values of common points. In other cases two distinct lines of traverses were found following the same boundary; this led to further uncertainty in the values of the fixed points, some of them differing largely. In many cases the differences were so large that a mean value could not have been depended upon, to furnish a correct basis for constructing topographical maps. The trijunctions formed the only common points between the two surveys that it was desired to combine together, and once an uncertainty was established in their positions, the work could not proceed. (2nd) The former survey had also failed to fix by traverse by far the larger portion of the trijunctions; in all such cases their positions could not be fixed with any approach to accuracy. (3rd) When the pentagraphing was commenced it was found that the patwari maps differed *inter se* where they adjoined one another. The month of November and part of December were altogether lost in endeavours to overcome these difficulties, but all attempts having failed, it became imperative that some fresh traversing to bind the old work together should be effected, as otherwise no trustworthy basis could be obtained. Traverse lines that were at first intended as check lines on the topography were consequently put in hand, crossing the country at distances varying from 3 to 5 miles apart, closing on as many village trijunction points as possible; when these lines had been surveyed and plotted and supplemented by the old traverse, a reliable basis was obtained, and the work of pentagraphing was proceeded with. Here, however, a fourth difficulty presented itself owing to the inaccuracy of the patwari maps; when the lines joining any pairs of trijunction points were used to set the pentagraph, the resulting distances between other trijunction points were found to disagree. This difficulty was surmounted by pentagraphing each village in two or as many more settings of the pentagraph as was found necessary. The labour of pentagraphing was thus largely increased, but the results obtained were vastly improved. This system of eliminating the error by scattering it throughout the village has been found quite successful, and has been since continued. In future, as all trijunction points will be fixed, many of the difficulties in this the first and experimental season will disappear.

The Phagwára Tahsil of the Kapurthala State, owing to greater incorrectness of the patwari maps, caused greater difficulties in pentagraphing than either Jullundur or Ludhiána districts. The patwari maps of Phagwara were surveyed some 10 to 12 years ago, and are certainly inferior to the work of the present time. The 4-inch maps of the former professional survey were of great help in adjusting these maps to their true positions. The course I adopted was to begin by taking the boundaries from the 4-inch maps, and having thus obtained the correct periphery of each village, a good basis was to hand for fixing the position of further details. The portion (38 square miles) of Phagwára that has been examined *in situ* has stood the test well.

The maps that have up to the present time been made available for reduction have been surveyed on the ordinary procedure of such surveys: they are undoubtedly good of their kind, yet lacking professional accuracy, as has been already commented on. In the last few years a new system of patwari survey has been introduced by Colonel E. Wace, the 2nd Financial Commissioner, designated "the square system," by which greater accuracy is said to be attained, but none of the maps surveyed on this system have yet been received. The first that will be supplied will be Umballa, and these may I hope be received during the recess of 1886, and if so, will be duly reported on. This 'square system' is not in use in other Provinces; it is however acknowledged to be only suitable for an open plain country like the lower districts of the Punjab. It may briefly be described as follows:—

In the village to be surveyed the patwari selects any convenient central open space, in which by measurement of sides and diagonals and cross staff he lays down on the ground a square of 1,000 feet sides; when he has got this first square correct he then proceeds by further measurements of sides and diagonals to extend its sides, until the whole land of the village has been divided into similar squares; when this has been done he is supplied with plane-table sheets on which squares have been drawn corresponding with the squares marked on the ground. On these he proceeds to fill in the limits of fields, &c., his basis being the corners of the squares, which are marked both on his plane-table sheet and on the sheet and on the ground. The correctness of this system, like that of all other systems, depends on the accuracy of the basis, or in the present instance on the degree of accuracy with which the squares have been marked on the ground. The task of laying down the square will not approve itself as an easy one even to a professional surveyor, yet the officers who have conducted measurements on this system are greatly in favour of it, and say that the patwaris soon learn to do it correctly. The patwaris themselves are also much in favour of it, and say they can always detect their errors when they go wrong, hence they have great confidence in it.

The system may be a very good one, but it appears susceptible of improvement by being based on the traversed points that are available from the operations of this party. If the two measurements can be combined, and to this no great difficulty should present itself, this system

may prove a valuable one worthy of extension to other provinces. Its great recommendation lies in its being prosecuted by the men of the country without any expensive instruments without involving any special training or mathematical calculations, and hence is well adapted for use by the ordinary village patwari.

For the Settlement Department the following records are prepared:—

(*a*) The traverse data for each village, giving, in the case of Ferozepore, the direct distance between the permanent marks, also (*b*) the plotting co-ordinates, and (*c*) a 2-inch index chart of the points shown in the traverse table. In the case of other districts, the direct distances and plotting co-ordinates between the tri-junction points together with an index chart on the 2-inch scale, are given. These are all prepared and bound in volumes, indexed, &c. As the traverse data could not be copied from the original tables, a large amount of labour has been entailed, and a great deal of time consumed in their preparation, which has largely added—far more than was anticipated—to the recess duties: this will be better understood when the large area traversed of 7,254 square miles containing 5,337 villages is kept in view.

Extract from the Narrative Report of COLONEL H. C. B. TANNER, S.C., *Deputy Superintendent, in charge Himalaya Party,—Season 1884-85.*

The triangulation of the Independent Himalayan tracts was continued by Mr. Barckley and myself, and now for a considerable distance all the prominent peaks visible from the British frontier have been fixed. Between Sikhim on the east, and the Gunduk on the west, very few peaks or ridges of any importance have escaped observation. Those which I regret to have lost are situated in the remote and little known region towards the head of the Arun river. I obtained very acute intersections to two groups, but before their positions can be relied on, they must be observed from some other point. It is only in the very clearest weather that comparatively low peaks of an altitude of about 19,000 feet can be observed from the plains when they are more than 130 miles distant, and the clear weather of the past season was too short to admit of my seeing those groups again, and though Mr. Barckley looked out for them later in the season they eluded him.

To the south-west of Everest we have lost a number of high peaks. They have been seen several times and observed more than once, but their shape was not sufficiently made out, through an atmosphere not quite transparent, to admit of their identification from two points.

The highest new peak secured in the Himalayas since the operations of the North-East Longitudinal ceased in 1850-51 is T 45, nearly 27,000 feet, reported on last year.

The gap to the north of Oudh in which we have no knowledge of snowy peaks, still remains unexplored by observers in the plains of India; but to its westward extremity I slightly diminished the hiatus, by fixing three mountain tops of an average height of about 22,500 feet. The observations were secured from stations in Pilibhít, whence an addition was also made to our knowledge of the lower ranges in the extreme south-west of Nepál. They were difficult to determine, being mostly flat and rounded, without knolls or abrupt points. They are all oak-clad, and the highest were seen to have a few groups of *Abies Webbiana*.

From Pilibhít my observations were carried northward near the Nepál boundary, and were concluded in Tibet on the gravelly plains of Takla Khár on the Karnali river. From the neighbourhood of Takla Khár, or Purang Jong, by which name it is known to the Tibetans, I had the satisfaction of determining my position in June, by observations made in March to the three mountain tops alluded to above. My guide, an intelligent trader from the Káli Valley, informed me that the three peaks belonged to a group called Yángri Yánksi on the borders of Tibet and Nepál. Looking at their northern face from Tibet, they had precisely the same outline which they presented to me when looking from the plains of India in the south.

From Tibet, owing to the numerous ridges and groups of perpetual snow peaks of lower altitude which surrounded the bases of these three higher points, the view was wild and confused, and without more time than I had at my disposal, impossible to unravel. The drainage from the Yángri Yánksi range is carried to the north by the Ráma river, which passes through a high country called Badingya, and joins the Karnáli near the famous shrine of Kojarnáth. The Ráma leaves the snowy region at the foot of the Yángri Yánksi range by a well marked gorge called Lakpu, which is flanked on either side by two fine, bold snow peaks. The country intervening between me and the gorge was a desolate series of sloping plateaux, divided from each other by ravines, and covered for the most part with extensive snow drifts. The game which one hears so much of was entirely absent, and, with the exception of a fox and a few common blue pigeons, I saw nothing.

My time in the neighbourhood of Purang Jong was short; I had made a forced march and crossed the Lipu Lek pass into Tibet immediately after a heavy fall of snow, and, before the officials at Purang Jong had time to stop me, reached a spot about a mile and a half from the fort. The Jong Pen, or officer in charge of the post, gave me a civil reception, but was not to be cajoled or bribed into allowing me and my party to cross the Karnáli river; but on my promising not to push my way by force, he allowed me to go about as I liked for a couple of days. The most southerly point reached was near the curious fort of Jidi Kot situated on a plateau above the Karnáli, with a row of immense colored *chortens** skirting the road

* A kind of temple within which images, religious books, and other objects of veneration are deposited.

to Takla Khár. Kojar Náth, one of the most noted shrines in the Himalayas, was just hidden behind a small white hill surmounted with *chortens*, at the foot of which flowed the Karnáli in several queer bends, winding about in a broad dreary bed of shingle. Far down the reach of the river was a roundish peak, said to stand on the boundary of Nepál. Above the shrine rose the brown slopes of Nimo Namling rent into three extraordinary valleys or more properly chasms. The northerly of these is Garu, the central one Dankichhen, and the most southerly Tangyeb. At the head of the Garu Valley, and at an altitude of about 19,000 feet, is a glacier that comes down from the summit of Nimo Namling; its sides are cliffs with sharp abrupt edges.

Through the Dankichhen chasm there is a route to the high lands at the head waters of the Brahmaputra, and one of my guides said that many years ago he had ascended the same with a party of four Englishmen who had forced their way past Takla Khár *vi et armis*, and paid no heed to the threats of the Tibetans who made vain efforts to stop them. The results of this enterprising journey I have been unable to ascertain. The party must have been quite close to the source of the Brahmaputra, perhaps without knowing it. They are said to have been intent on shooting wild *yaks*, which are not uncommon in the high region beyond the Nimo Namling range. The Tangyeb, or most southerly of the enormous rents in the face of Nimo Namling, has no exit at its upper end, nor could I detect a glacier. At its head rises a most remarkable abrupt peak, which is almost too steep to allow snow to rest on its facet-like sides. It is about 23,000 feet high, and may perhaps be visible from the plains of India, but to its south there exists an extensive array of ranges which may happen to cut off the view.

Nimo Namling, called by Mr. Ryall Gurla Mandháta (Gurla was pointed out to me to be a smaller mountain towards the south-west shore of the Man Sarowar lake), is reported by Tibetans to be the highest mountain in Western Tibet. It has an altitude of over 25,000 feet, but standing on an undulating plateau of more than half its height, its appearance is not very striking. The summit is quite flat, and the slopes, which are rent by the Garu chasm, are gentle and almost unbroken. To the north of Nimo Namling the spurs of the holy mountain of Kailás were just visible under a dense canopy of cloud that did not lift all the while I was across the Tibetan boundary. South of Kailás were a series of roundish uninteresting hills just sprinkled at their summits with snow. The highest of them stands near the southern shore of the Man Sarowar lake, and was determined by Mr. Ryall to be over 18,000 feet high by trigonometrical observations taken from his stations to the westward of my position.

Before returning into British territory, we visited a point near the Lipu pass, whence we obtained a fine view of the remarkable and imposing mountains that form a close cluster about 8 miles south of the pass. It is in the midst of these perfectly snow-clad peaks that the boundaries of British territory, Nepál, and Tibet meet, but the country is so wild and the climate so severe, that, except in the height of summer, the valleys are quite deserted. From this cluster the Nepál-Tibet boundary runs along the Yángri Yánksi range before alluded to, but it is as indefinite in this neighbourhood as it is on the extreme north-east corner of Nepál, where the beautiful peak of Jaunu in North Sikhim forms one of its boundary marks. We know nothing whatever of the extreme north-west corner of Nepál, where the Yángri Yánksi forms the boundary: our only geographical information of the tract in question is the three snow mountains fixed by myself.

Humla, which is to us nothing but an empty name, is a tract to the south or east of the Yángri Yánksi, and three days down the Karnáli river from Takla Khár. Shortly after crossing the Lipu Lek pass we met a man of Humla, whose hair was raised up on the top of his head by being tied tightly together in the shape of a cylinder about 9 inches high, giving him a remarkable appearance. He called his tribe Katbir, but the men with me styled him a Rongpa, which means simply a man who lives in Rong or very broken mountainous country. The Katbirs are Buddhists, and partly subject to Nepál.

Our visit to Tibet was too short, and our movements too much restricted, to enable us to do much geography, and, as it turned out, we found the existing map, which was chiefly due to the excellent sketch by Strachey, required but little alteration.

I believe that it would be very difficult to penetrate into Tibet beyond the neighbourhood of Takla Khár, owing to the increasing distrust of the Tibetan officials who view our road-making in Darjeeling and Kumaun with the gravest suspicion. Every Tibetan is firmly convinced that sooner or later we intend to annex their country. Formerly it was possible to enter Tibet by bribing the officials, but as years pass the country is becoming more closely guarded, and now there are few passes by which an European can get in. The annexation of Burma is an event not likely to ease their minds, and it is probable that in future the Lipu Lek pass will be watched with greater vigilance than ever.

The Lipu Lek pass, about 16,800 feet, is one of the easiest that connects the trade route of Tibet with India, and though it taps a tract which is not so populous as Eastern Tibet and has to be carried over one of the most arduous roads in the world, the trade is already very considerable. The dangers and difficulties of the Nirpánia-ki-dánda or waterless spur, which occurs between the Lipu Lek pass and Kumaun, are not sufficient to check the export and import of a large amount of grain, salt and borax; and when the road now under construction, which avoids the worst part of the route, shall have been finished, the traffic will probably increase. The Jong Pen or Governor of Takla Khár asked me what was the object we had in making this road; why did we wish to leave the beautiful plains of India for such a barren country as Tibet? "Tibetans," he said, "liked to remain in their own land, how was it that we English were always craving for the territories of others"? I informed him that the English

did not in the least desire to occupy such a comfortless and bleak land as theirs. "Bleak, do you call this? Why, you are now in the very garden of Tibet. If this you call barren, what would you say of other parts where there is literally nothing but rock and ice! Go back now to India, you have seen the most inviting part of our country, the rest is not worth a visit. We are not angry at your coming this once, but we never wish to see you again. Our Government don't allow the English in Tibet; but you, one and all, try to push your way past our frontier posts, and never consider that if you succeed, our Governors and officials on the frontier lose their heads for not stopping you." This Jong Pen was accompanied by an old one-eyed Lama who backed him up in impressing on me the futility of endeavouring to penetrate beyond my present camp. I was presented with a small offering, but R. N., my companion, considering it too trifling, refused it. The Jong Pen and Lama therefore returned me the present I had made them.

The monastery and fort of Takla Khár, which was distant about a mile-and-a-half, looked quite inviting, with its various many colored buildings that stood up conspicuously above the walls. Below the fort, and surrounding it on two sides, extended a scarp which rose from the Karnáli river on the east and the Pala stream on the south. R. N. made a telescopic sketch of the place which did him credit. Viewed from the camp the great mass of Nimo Namling formed a suitable background, and close below our position commenced a level expanse of wheat fields here and there dashed with snow. The monotonous brown and yellow, which at this season of the Tibetan spring (June) pervades all nature, gives way in July and August to a pleasant green. The gravelly soil was now fairly sprinkled with the remains of annuals of the past year, but only a few buds marked the returning warmth. Down the whole length of the Karnáli valley I was unable with my telescope to detect a single bush. The spare vegetation that probably once covered the most sheltered localities has long since been completely eradicated, for I found the people digging up from the very roots the thorny plants which are still to be found. My guide informed me that once the less exposed spots of this high tract (about 13,000 feet) contained trees, for in the Dankichhen ravine their stumps may still be seen.

It is because of the great difficulties of the passage of the ridge called the Nirpániaki-dánda that this remote pass, which leaves the British territory near the extreme north-west corner of Nepál, is so little visited, but the new road now being made will open up what I conceive to be the finest scenery in the Himalayas. From the summit of the Lipu Lek pass the Indian landscape is dreary and ghastly in the extreme; masses of snowy ridges broken by staring masses of rock form the entire view. In the beginning of June, the whole of the mountains from summit to base were deep in snow, and near the top of the pass the last fall had been eddied into immense snow drifts not less than 50 feet high, and forming on one side of it a deep hollow which in our descent we were cautious to avoid. Snow continued for about a couple of hours' journey down the British side, after which we came to Tára, a cheerless place where we found the remains of a stone wall for shelter. Pushing on from Tára we camped at Kálipáni, the reputed source of the Káli river where snow lay only in drifts. Above Kálipáni there rise at a short distance towards the east some most remarkable snow peaks, and over against the terraced field, in the other direction, there stands a most beautiful conical peak, one side of which is cut off into a sheer cliff. The bases of these mountains are clothed with masses of creeping juniper, intermingled with smooth turf and grey rocks, and below Tára at about a mile the first stragglers of the pine and birch forest are visible down the valley.

The Káli branch joins the main stream at Kángwa, a short half day's march from Tára, and no sooner does one turn into the main valley than the scenery becomes beautiful beyond description. The bed of the valley undulates and bears alternately bands of dark pine and turfy terraces dotted with single trees. Craggy mountains rise on either side, and in the midst flows the clear green water of the river. The background is formed by Api mountain, which for the purity of its unbroken snow and boldness of its outline, I have nowhere seen equalled. The ridges that connect the highest with the lower points of Api are perfectly sharp and decided, and for several thousands of feet there is scarcely a splinter of naked rock to mar the unrivalled whiteness of its slopes. The base and lower spurs of Api touch the Káli valley and are clothed with variegated masses of birch and pine, except in those places where constantly recurring avalanches admit only of the growth of short grass. The remains of the avalanches of the preceding winter still lay as lines of snow down the slopes, and *yaks* licked up the young herbage which was just beginning to come up. Api was gradually lost to view as we approached him, but his place was taken presently by Namju, a beautiful snow peak which appeared above the flat ridge of the great moraine beyond the picturesque village of Garbiang, perched high above the river on a huge natural terrace. This terrace is apparently the remains of the bed of a lake which once occupied the valley from the moraine a couple of miles below Garbiang to a distance of one day's march above it. Traces of the old lake are visible here and there for many miles in the shape of a great level terrace. The moraine which once blocked the Káli valley, and by the accumulation of silt so formed the lake, was due to a glacier from the south side of Api, but now that glacial action has diminished in these parts, the moraine no longer receives additions, and the river has gradually cut the dam away and is now slowly removing the silted up bottom of the valley. From the reduced glacier of Api there now descends a considerable stream which rushes over the precipitous lower slopes of Api, and just at its very foot forms a most glorious feathery cascade.

From Garbiang to Budi, the next village lower down, the road, to avoid difficult places on the banks of the Káli, has to make a considerable ascent over the moraine before-mentioned, from the summit of which, during my journey up, I noticed the top of

the waterfall just visible through the mass of pines that skirt the road, and determined to visit it. Taking some guides from Garbiang I went down the Káli instead of ascending the moraine, and after a difficult journey found myself at the bottom of the wildest place I have ever been in. On one side rose the cliff of the moraine backed by the mountains on the right bank of the Káli; opposite towered more cliffs fringed, wherever there was standing room, by forest trees, and down the face of the overhanging scarp in front of me poured the waters from Api in a feathery cascade of great volume and with a fall of between three and five hundred feet. The foot of the fall we could not see as it descended into a deep abyss where it was lost in the unseen Káli, which thundered and roared along immediately below our feet, but how far below us we could not say. Sheets of spray filled the cleft of the Káli and were blown hither and thither across the face of the cliffs, and the sun which was well over head lit up the great hollow at our feet with a mass of bright prismatic colors.

Having visited this fall which is called Yánglá Dhár, it was a question whether we should return by the way we had come or try and reach my camp by continuing our journey down the valley of the Káli. We decided on the latter course, and though none of my men had previously visited this extraordinary place, they said that there might possibly be a means of skirting the cliffs, but that of course there would be bad places. Bad places there were indeed, and before long, when clinging to the rough places in the face of a slope that was nearly a cliff, I fervently wished I had not come, and sometimes, had it not been for the friendly grasp of R. N.'s hand, I believe that I should not have emerged safely out of this awful valley. Gradually the dangers of the road became less, and towards evening we reached the most beautiful and charming village of Budi—literally the most delightful place I have seen in the Himalayas. Four valleys converge on Budi, the view of each could occupy an artist for a month. Spreading terraced corn-fields skirt the foaming Káli, and here and there on the mountain sides small terraced spots, surrounded with many tinted forest trees, support the quaint houses of the cultivators. The mountains on the north-west side are partly covered with short crisp turf which is broken by scarps and adorned with clumps of pines and birch. The north-east face of the slopes are generally covered with dense forest of dark and light colored pine and birch relieved by crags of the richest tints. My tent was pitched under a wide spreading walnut tree, and just behind it rose a frowning cliff with broken craggy base, partly terraced and partly dotted either with pines or great fragments of rock. High up above the forests the glistening snow capped every mountain around. Budi itself is perched up in the face of the cliffs of the moraine I had just passed round on my way from the Yánglá Dhár falls.

The finest peak in the immediate neighbourhood is Namju, which rises up just opposite Budi on the other side of the Káli. It is seen to the best advantage from the undulating summit of the moraine, which in summer is covered with grassy knolls and beds of flowers, and framed in with a dark belt of pines. In the beginning of June, the time of my visit to Budi, the snow still extends low down on the mountains, and the delicate green of the patches of young grass and of the budding birch trees contrasts pleasantly with the rich russet tints of the vegetation of the preceding summer. Later in the year most of the snow disappears, and the slopes, up almost to the snow line, are overpowering green, except where broken by the highly colored rocks and the dark masses of the spruce fir. Below Budi the Káli valley narrows, and though it loses its more beautiful features, it perhaps makes up for it in assuming a wilder and more rugged aspect. At one day's march below Budi the passage of the Nirpánia-ki-dánda or waterless ridge commences; it has taken the ceaseless toil of generations to construct the series of stone-steps or ladders over which the traveller has to make his way for a day-and-a-half before he reaches an ordinary mountain path. This extraordinary trade route consists of a kind of winding stair-case which is carried up and down in the face of cliffs in many places overhung with crags and with seemingly an almost bottomless abyss below. The rough steps are built into the rock wherever it has been possible to find foot-hold.

On my return from Tibet, the whole route was literally crowded with thousands and thousands of laden sheep and goats making their way into Tibet. This journey, at any time arduous and fatiguing, was now rendered even dangerous by the obstinate sheep which taking fright would rush past us without regarding the consequences either to themselves or to us. Many animals are annually precipitated over the cliffs, and it is a wonder how even the exigencies of the salt and grain trade with Tibet can have compelled the adoption of the route for so many years over such an awful piece of engineering work as the stone stair-case along the Nirpánia-ki-dánda. Near the lower end of the series of stone ladders, and just before descending into the first fairly comfortable camping ground after crossing the Nirpánia-ki-dánda, a splendid view of the Lingru mountains may be obtained if the traveller will ascend about 1,500 feet above the road to one of Mr. Peyton's trigonometrical stations. From this place we saw an avalanche tearing down the slope of Lingru which faced me at a few miles distance on the Nepál side of the Káli. The roaring of avalanches was daily heard in this country, but the one now alluded to, though quite noiseless, carried with it a large quantity of snow and sent up clouds of powdered ice long after the movement had ceased.

Next to Budi the group of villages round Sirdang may be regarded as those which carry off the palm for beautiful surroundings. Here are seen the *Abies Dumosa* with their wide-spreading cedar-like tops growing to a great size and with that peculiar sweep of the upper branches which distinguishes this tree. On the terraces of Sirdang grows a remarkable large-headed barley, and the mountain sides are clothed with a great variety of trees including the dark kind of oak, *Abies Dumosa*, *Pinus Excelsa*, yew, and *Abies Webbiana*, and higher up

birch and juniper. A little beyond Sirdang the road crosses a pleasant little Welsh-like pass, whence on the road to the plains of India *viâ* the Káli river the last extensive view of the snow is enjoyed. Here one bids good-bye to oaks and pines and to alpine scenery. A wearisome journey over many deep valleys and steep ridges takes one to Naini Tal, and it may be said that scarcely in a single place *en route* is there now sufficient shade to cover the smallest tent, so complete has been the destruction of forest trees and even trees that once protected the camps. The once beautiful river banks with their overhanging foliage are now dotted with charred stumps and copped tree trunks. For days one may travel in this country without finding a single tree of natural growth, and it is a question whether the uninteresting journey over the treeless ridges of North-East Kumaun is worth undertaking, to enjoy even such unrivalled scenery as that to be met with above Budi on the Káli river.

During the month of April the trigonometrical stations near the eastern border of Kumaun were visited, and a number of points in Western Nepál fixed from them. The area visible from some of these stations was large, and though no great mountains were seen in the far east, yet we secured a good deal of useful topography of a sketchy kind. During April, the range which extended along the horizon line was fully snow-clad, and, until we computed the heights and distances of some of the points, we were under the impression that the range was far more remote and of much greater altitude than we found to be the case. The most distant mountains which we fixed in Nepál are round and smooth downs with scarcely any rocky features, they have an average height of about 13,000 feet, and are probably covered in summer with grass, being just above the limit of tree vegetation and below the almost barren belt which skirts the perpetual snow line.

The far off downs mentioned above are on the right bank of the Karnáli river, and apparently emanate from the Yángri Yánksi group alluded to in this report. The angles fixing this remote range are very acute, but when our observations are made from stations in the east of Pilibhít, we shall much improve the work. As we advance to the eastward, skirting the lower Himalayas on our way across Basti and Gorakhpur, it is to be hoped that the unknown section of the Himalayas lying to the north of those districts will be no longer represented on our maps by hill-shading which is the result of theoretic geography. How it has come about that over so considerable an area we have for the past 40 years secured only a single fixed point, I am unable to say. It was hoped that the work would be taken in hand the ensuing season, but the demands for other surveys have had to be complied with, and there is no assistant now available for the purely geographical operations which I have been prosecuting for the past three years.

The triangulation of the strip of Western Nepál visible from the hills on the Kumaun border was one of the pleasantest pieces of work I have performed for some time. The hills whence observations were taken were not too high; the open terraced tracts round Champáwat and Pithoragarh were seen at their best; the fruit trees were in blossom, and the pretty rills of water had not yet dried up. Until June the hill tops were hardly ever cloud-capped, and, except on some hazy days, work was constantly in progress. In Eastern Kumaun there are some delightful Deodar clumps where one can pitch a camp in a climate which is neither too hot nor too cold. Though we seldom had days sufficiently clear to enable us to make out the most distant groups of mountains, we had about three or four times the amount of clear weather usually enjoyed in the Eastern Himalayas. Throughout my work in Kumaun and Tibet I was accompanied by R. N. who has several times been mentioned in this report.

Original Narrative Account by R. N. of his exploration of the country to the North and North-West of Kinchinjanga made in the autumn of 1884, with Notes by COLONEL H. C. B. TANNER, *Deputy Superintendent, and* MR. W. ROBERT, *Surveyor, Survey of India.*

Having received orders from Colonel H. C. B. Tanner, Deputy Superintendent, Survey of India, in charge Darjeeling and Nepal Survey parties, to observe Tibet and Bhootan Peaks and obtain the topography of tracts adjoining Sikkim, I left Darjeeling on the 2nd October 1884, and marching for 12 miles we reached Jore Pokhiri, a Travellers' Bungalow, where a heavy shower of rain kept us in great trouble during the night. Next day before dawn we resumed our journey, and proceeding 11 miles from the last stage, we halted at Tongbe, a Travellers' Bungalow.

On the 4th we stopped at Sanduphu Travellers' Bungalow, 15 miles distant; here a heavy fall of rain detained us for two days. At Sanduphu N. S. I observed some snowy peaks in Nepal. On the 5th we reached the Travellers' Bungalow at Phallat, and having found the Survey Station of the same name, I observed some more snowy peaks in Nepal on the 6th.*

* Here the Darjeeling-Nepal Frontier road terminates and a large masonry pillar marks the trijunction of Darjeeling, Nepal, and Sikkim boundaries. H. C. B. T.

The 7th October brought us to Singali Thang.† To-day we met several ascents and descents and crossed two footpaths, one which branched off to Tablang Jong‡ or Khallangá fort, *viâ* Mia Khola Valley and another from Singalila pass to Mai Khola River. Grass was abundant, and water can be had from a small spring which could supply 30 men. A stone pillar marking the boundary between Sikkim and Nepal was found in the encamping-ground. A footpath to the east runs to Pemionchi monastery *viâ* Hi village in Sikkim and

† The Nepalese name is "Chia Bhanjan," a halting-place in a grassy depression of the range. W. R.

‡ Or Taplong Jong. W. R.

A most interesting trip may be made from Darjeeling to Sandukphu and Phallat and then along the Singalila range to Chia Bhanjan here described by R. N. From Chia Bhanjan a fair road leads to Pemionchi through rather a pretty valley. Tassiding and Kalong monasteries may also be visited. The return marchi to Darjeeling would pass over some very interesting country.

on to the sulphur springs of Ralong Sachu resorted to by the Nepalese for its medicinal properties. On the 8th, still keeping northern direction and working up the ridge, we passed a hollow on the crest filled with rain water. From about here a footpath goes to Nepal territory. Descending 3 miles along the ridge we passed a small oblong lake, some 30 × 100 feet, which supplies water to cattle belonging to the residents of Sikkim brought here in summer for pasturage. Continuing our journey for half a mile along crest of ridge we stopped for the night. To-day we saw along our route a number of *munal* and blood pheasants.

On the 9th October 1884 Megutak cave was reached. It gives shelter to traders and travellers during the rainy season. About this cave was a small tolerably level plain on which some 20 tents can be pitched side by side. From Singali Thang to Megutak cave water is procurable by one who has a knowledge of the route.

On the 10th, marching along the Nepal-Sikkim boundary and fording a stream flowing east to west, we saw a straight but narrow footpath which runs to Yampung.* Not ascending this we adopted a circuitous but wide road, and continuing our progress for a mile, we saw a small stream on the left flowing south called by the name of Mai Khola River, or Changthap. Ascending for a mile we reached Yampungla pass, and thence descending for 4 miles we arrived at Yampung cattle-shed of five *pakka* houses, built by the inhabitants of Sikkim, who during the summer season bring their *yaks*, some 200 in number, for pasturage.† Round the village some dwarf trees are found, but half a mile to south-east pine trees grow from 40 to 60 feet in height. This village is connected by a road from Pemionchi Monastery‡ *viâ* Rungbi valley and Salot village. This monastery is situated on a conical-shaped hill, where some 150 *Dapas* (priests) reside. It is the head monastery in Sikkim, and its supremacy is acknowledged by other *Dapas* who have to observe certain rules of celibacy, and to break them will cause their exclusion from the monastery. In case of a vacancy of head ruler occurring in any other monastery, a *Dapa* under the title of Lama is sent from this to fill it up.

* The Yampung plateau seen from the Lampheram Peak on the boundary watershed of Sikkim and Nepal forms a magnificent middle distance to the great mass of Kinchinjanga situated but a comparatively short distance behind it. Jummoo stands apart to the left and the dark mass of Kangla visited by R. N. stands out boldly from the snow slopes of that fine mountain.

Below Kubra are smooth snow fields pierced here and there by great splinters of black rock. The early morning sun shines aslant on the landscape, and lights up the higher points most brilliantly whilst the depressions are still cold and gloomy. The summit of Lampheram, which forms the near foreground, is covered with many coloured vegetation broken here and there by grey masses of boldly-shaped rocks. The slopes of Lampheram are clothed with an almost impenetrable mass of rhododendron. H. C. B. T.

† The ridge on which R. N. travelled up to this point and for some distance beyond was surveyed under the greatest difficulties by Mr. Robert some three seasons previous to R. N.'s visit. Mr. Robert's knowledge of North Sikkim is second to none. He has revised part of this account by R. N. H. C. B. T.

‡ Pemionchi monastery acknowledges its subordination to the great Lama of Sakia and not to the grand Lama of Lhasa. H. C. B. T.

On the 11th, we walked over snow, and proceeding 2 miles onward we visited two lakes under spurs, each about 300 feet in circumference. After a difficult ascent of 1½ miles we reached Dhoila Pass, which traders have marked with a heap of stones to mark the route. I cannot explain the amount of trouble we had to undergo here. No sooner had we reached the pass than clouds spread over and snow began to fall. In darkness, although almost unable to trace our way, we still continued for half a mile along the ridge, and presently we found a stream, whence we all determined to slip down along the right bank of this stream into the valley below where we expected to find some fuel to warm ourselves. At last the whole party, except two of my companions who could not move, being much affected by snow, slid down and fortunately reached a knoll about 9 P.M., where we passed a most horrible night without fire and food. Next morning we succeeded in getting down those two companions left behind. We returned our thanks to God for saving our lives, because had we not stopped here and had we continued our slide for another 200 feet, we should all have been precipitated into a *khad* below.

On the 12th, leaving the stream to the left, we descended abruptly by a winding path in the Kurmothang valley and rested for two hours in a cattle-shed on the right bank of the Kurmothang-Chhu. After taking our meal we crossed the river by a wooden bridge, 20 feet long, and proceeded up to "Bockto" of three cattle-sheds. It is situated on the slope of a spur and at the junction of two footpaths, one to the east leads to Jongri, a *pakka* cattle-shed in Sikkim, and the other to Tseram village in Nepal. There is a scarcity of grass and fuel. This place is much frequented by traders of Khongbachen village who go farther east to exchange salt for *tsod*, a kind of creeper which yields a red colour.

The Kurmothang valley contains an extensive grassy plain, 300 feet broad and 700 feet long, surrounded by (*Dungshing*)§ pine and rhododendron trees and watered by the Kurmothang-Chhu, which takes its rise from Tshodomdong lake and flows to the south.

§ Dungshing is the Abies Webbiana of Sandakphu. H. C. B. T.

Next day, following the second footpath over snow for 2 miles we visited two lakes, the larger of which is named Tshodomdong, so called as its water bears a resemblance to the green colour of peacocks' feathers. It is about 200 feet in circumference, and its water looks from a distance of a dark-green colour. This lake is an object of great veneration to the inhabitants of surrounding countries. These two lakes receive their supplies of water from Kángla ‖ snowy peak.

‖ Kángla a well-known peak of broken snow on one of the spurs of Kubra and visible from Darjeeling. Captain Harman made an effort to visit it, but was prevented by a great fall of snow. Mr. Robert also made the attempt, but his provisions failing he had to return. There is an immense panorama of snowy mountains visible from this point, including Everest and its spurs. H. C. B. T.

The next day, after a difficult ascent of a mile, we reached the Chumbap Kángla Pass, where a fall of snow detained us for four nights. On the 16th I surveyed with plane table at the pass and fixed some snowy peaks.

On the 17th we crossed the "Chumbap Kang" range, which runs in a direction of north and south. This pass is said to form the boundary between Nepal and Sikkim. A precipitous descent of a mile brought us to a stream which we forded; this stream rises from the Kángla Snowy Peak. Hence the road becomes comparatively level and turns to the west. Half a mile further we crossed another stream which issues from a lake and flows to the south. We noticed *en route* some dwarf trees on the slopes of spurs about a mile to south of the road. Some 2 miles onward we arrived at Chooloung Kyak, a cave wide enough to give shelter to some 15 persons. Here we rested for the night; water, grass, and fuel were procurable.

The next day, after an ascent of 3 miles, we crossed a pass over a ridge covered with snow, then descending for 2 miles we crossed a river by a wooden bridge 30 feet long. Following the right bank of the river for 3 miles we reached Sema-ram, a cattle-shed. This river is said to take its rise from the Kanglonangma pass, and receiving several tributaries from the west empties itself into another river called Yalloong, which comes from the Kinchinjanga Snowy Peak.

On the 19th, progressing 3 miles, we crossed the Yalloong River by a wooden bridge about 50 feet long, and thence ascending for 300 feet we reached Tseram village, which is situated in a grassy level plain terminating on the north-west side by a ridge. It contains some 5 *pakka* houses. The inhabitants keep about 150 *yaks*, which are used as beasts of burden. The tract abounds with game; for instance musk-deer, *semus* and *munal*. We here replenished our stock of provisions which had run short. The village lies at the junction of four roads, one runs along the right bank of the Yalloong River *viâ* Ta-oong village to Taplong Jong Fort; the second runs north-west to Gunsa village, third to Upper Yalloong, and the fourth is the one we came by. Here a tax-gatherer is left by the Ruler of Yalloong to raise taxes, one rupee per head, from traders, and we were also obliged to pay R15 at the same rate. Here we engaged two guides to show us our road.

Next day, we started for the Yalloong Kang Snowy Peak, and ascending along the left bank of the Yalloong River we visited the Upper Yalloong village, the summer resort of the inhabitants of the Lower Yalloong. This village contains some 40 *pakka* houses and *chortens*,* small temples, marked with flags. We were astonished to find all the houses locked up, but on inquiry it appeared that all the inhabitants had temporarily left their houses which contained all their goods. On the right bank of the river we saw a monastery named Tashi Chading† in a dilapidated condition. It is said that for the past 11 years this monastery has been deserted and a new one was built at the Lower Yalloong instead. A market is held here during summer, and traders from different parts of the country come to exchange their articles. From this place glaciers are visible, and they cover the head of the river. Cows and bullocks are held sacred; they are never used as beasts of burden and any person infringing this custom undergoes a severe punishment.

* Called *Chutens* by some.—H. C. B. T.

† Visited by Hooker.—H. C. B. T.

Marching for 3 miles from the village we visited a large cave under a rock used as a retreat by a Lama who devoted his life to holy worship. Proceeding for 3 miles we were detained by a fall of snow for three nights. On the 23rd morning, after an abrupt ascent of 2 miles over snow, we reached Yalloong Kang Snowy Peak, about 19,000 feet high. Here peaks were observed and the country surveyed. On the 24th we returned to Tseram village, and thence proceeded to Phukpa-Karmu *viâ* Semaram and Tongak Kang. Phukpa-Karmu is a large cave, which gives shelter to passengers and traders against snow and wind. Next day, with great difficulty, by aid of ropes we climbed over Kángla Snowy Peak, whence I observed some snowy peaks, and we returned to the same cave. About a mile to the east of the cave is the Kángla Nangma pass, whence a road runs to Sikkim *viâ* Jongri. On the road between Phukpa-Karmu and Jongri is a cave called Tiwogyaplag,‡ a halting-place for passengers. Six miles to the west of Phukpa-Karmu and between two ridges there is a lake about a mile in circumference with other small pools to the north of it, which from a distance seem to contain water of different colours. From this lake a stream flows to the south and joins the Semaram river. On our way to take observations to the west of Phukpa-Karmu we stopped for a night on a grassy slope, some 200 feet north of the lake. During the night snow continued falling so that our tent bent with its weight, and we were suddenly awakened, and with great difficulty got out of the tent and started at once without food for Tseram.

‡ Tegyapla.—H. C. B. T.

On the 2nd November we left Tseram village, and ascending 3 miles we crossed a pass, and thence slightly descending for 2½ miles we reached the junction road which runs to Tablang fort *viâ* Yalloong village. This is the road which is adopted by the Bhutia traders who trade in salt and rice carried by sheep in hundreds. Marching 3 miles further we rested for a night. Next day after 7 miles journey we arrived at Gunsa village.

Gunsa is a large village situated in an open and flat valley enclosed on all sides by snowy mountains, which rise in precipices to a stupendous height. It contains 150 stone and wooden houses, and some of them are two-storeyed. The Khongbachen River emanates from the Jonsongla pass to the north, and dividing the village from a *Gompa* or monastery, surrounded by some 40 *pakka* houses belonging to *Dapas* (priests), it flows through a narrow valley from the south of the village and joins the Yalloong river. This stream is bridged over in a

number of places with timber to facilitate communication between the village and *Gompa*. Here we found some patches of cultivation; the chief production of the soil is wheat, potatoes, barley, and *phaper*, a kind of grain, and other vegetables. The inhabitants are well-to-do people, generally engaged in trading business. Women here spend their time in weaving blankets. Men and women in the village every night go from one family to another to interchange visits, when they are treated with courtesy and presented with cups of *mowa* (a kind of liquor) and fruits, &c. Thus they pass their nights in song and dance. In case of a death occurring in the village their jolliness is stopped for three days. They observe Tibetan customs. They keep *yaks* and goats and sheep. They are ruled by a headman, whose duty is to collect revenue and taxes. The village lands are fenced round to protect them against musk-deer and *burrel* (Nao) and *munal*, which the villagers are forbidden to shoot. The *Gompa* (monastery), being the repository of religious books and images, is governed by a Lama, whose supremacy is acknowledged by the villagers who monthly send food for him and his disciples (*Dapas*). We passed five nights here.

On the 7th, having crossed the Khongbachen River and ascended for 7 miles, we reached Nanghola Pass, whence we saw, 7 miles to the west down in a valley, a small city called Walloong Zom on the junction of roads, and between two rivers, the Yongma and the Walloong. It contains some 300 houses and a row of shops on either side of a road running through the town. Next day we retraced our steps to Gunsa.

On the 9th, proceeding 7 miles along the right bank of the Khangbachen River, which is fed by several small streams from the right and left, we crossed the river to the left by a wooden bridge, and following up the left bank for 2½ miles we reached the Khangbachen village, the summer location of the inhabitants of the Gunsa. The village at the junction of two rivers called the Thonak, and the Thongchen containing *pakka* houses, was found empty on account of the cold season, and was surrounded by barley fields. To the east and opposite the village the Janu (or Junnoo) Snowy Peak is visible, which is an object of worship by the inhabitants of Gunsa. There is a scarcity of firewood and grass. Here a companion of our's fell ill, and from this place he had to be carried.

The Jansongla Pass, which is about 2 miles south-east of the junction of the boundary of Nepal, Tibet, and Sikkim is a continuation of the Kinchinjanga range, and is about 20,000 feet in height. Continuing on a northerly course from Gunsa we came to Khangbachen, 9 miles; then going on for 7 miles we came to Lanok, a cattle-shed, where a road diverges *viâ* the Chabukla Pass to Tinkijong. From Lanok we proceeded up the river crossing 5 miles of a moraine and 4 miles of a glacier, reaching the Jansongla Pass on the 7th day from Gunsa. This pass cannot be crossed unless assisted by some 15 men in making a passage over snow. The nearest pass to the west is Chabukla, about 19,000 feet, and to the north Chhorten Nyima, which we afterwards visited; to the south the range cannot be crossed.*

* The route described by R. N. was some years previously followed by Babu D. C. S., and the Lama W. G. At that time the Lama was ignorant of surveying, and besides, the journey was made under most trying circumstances when snow fell daily, so that even had he known how to take them, observations could hardly have been made. The route, however, was plotted and the map published, but the errors of the Lama's distances and angles were sufficient to throw the position of the Jansongla and Chhorten Nyima Passes many miles to the west. The Lama has crossed and measured the height of over 90 passes, and he informs me that he thinks the Jinsongla or Jongsongla is the highest and most difficult he ever attempted. In the first edition of the sketch map of North Sikkim by Mr. Robert the name Jinsongla has been placed opposite a wrong pass from erroneous information supplied to that gentleman by his guides. A second edition of this sketch map will contain a number of corrections and all the new geography to the north-west of Kinchinjanga by R. N.

H. C. B. T.

Resuming our journey to the east by an abrupt descent of a mile, and proceeding for some miles over a moraine, we arrived at Chizin Lhe, a cattle-shed. Thence we turned to the north and reached the Chhorten Nyima Pass which is on the boundary between Tibet and Sikkim. Along the right bank of the stream which rises from the pass a route runs to Longijong fort. After a day's journey it crosses the Chichu River which issues from Nuijin Songra† Snowy Range and flows to the west. The fort, which is about 7 miles from the river, is surrounded by a small lake. The fort is governed by a *Jongpon*, a tax-gatherer. To the north of the fort, about half a day's journey, is a large lake called *Chomotel-tung*.‡ Retraced our steps from Chhorten Nyima Pass to Chizin, a cattle-shed, and thence resuming our journey to the east along the left bank of Zemu River we reached Shonak (flat), a cattle-shed. Our stock of provisions had run short, and we were obliged to live on game. Some 2 miles from Chizin, the cattle-shed, we saw the foot-prints of a wild *yak*. We traced the marks for 4 miles when we came across two wild *yaks*, and tried to catch them alive, but they escaped. Our two companions who fell ill died at Shonak flat. Marching for four days without food we arrived at Zemasamdong at the junction of Lachen and Zemu Rivers, where we replenished our stock of provisions which had run short.

† Nuijin Songra peak was fixed by R. N. during the operations he is here describing; it was seen by Hooker, Harman, and Robert from the Donkia Pass, but not fixed. It is an important geographical point being seen from a wide extent of country, its height is not quite 20,000 feet. H. C. B. T.

‡ Chomotel-tung partly surveyed by Lama W. G., and partly by explorer M. H., or No. 9. H. C. B. T.

Leaving Zemusamdong cattle-shed on the 5th December 1884, and marching for 4 miles to the south we reached the Lachen or Lomting village. This village is situated on the small table-land on the west of the Lachen River. It contains some 110 *pakka* houses and a small monastery to the north. The villagers are well-to-do people, and their trade consists in carrying canes and beams, planks, &c., to Tibet. They possess numbers of *yak*, sheep, and goats, utilising the milk of all their animals very largely in their food. The women are generally engaged weaving blankets of various kinds, which are sold in Sikkim. Besides blankets they take to Sikkim for sale salt, earthen pots, musk, &c. We stopped here four days.

Having taken leave of the Snowy Range we came to Darjeeling *viâ* Chungthong and Tumlong on the 31st January 1885.

Extract from the Narrative Report of MAJOR A. W. BAIRD, R.E., F.R.S., *Deputy Superintendent, Survey of India, in charge Tidal and Levelling Operations;—season 1884-85.*

During the past year two stations, Beypore, and Vizagapatam, have been dismantled and the instruments removed, as the observations have been completed at those stations. The instruments were sent to England to be modified and to have all the new improvements similar to the last sets of instruments as altered by Messrs. Légé & Co. I expect to receive them before the end of 1885: one set will be placed at Cochin and the other at Cocanada, at which places arrangements are being made for the erection of the observatories formerly in use at Beypore and Vizagapatam. I regret to say the tidal station at False Point has ceased to exist: the storm-wave caused by the cyclone which passed over False Point on the morning of the 22nd September was most disastrous, and not only the observatory with all its instruments, but the Port Office, Custom Office, and in fact the whole village of Hookeytola, have entirely disappeared. The observatory clerk was swept away, and from the newspaper reports I learn that only two people out of all the residents of Hookeytola were saved. The tidal observations at False Point would have been completed in May next, and in fact arrangements were in progress for the removal of the instruments to Chittagong when the work was finished. It will not be necessary to continue the observations at False Point, as the data which have already been obtained will be sufficient, but it is disappointing that the 5th year is incomplete. The loss of the instruments will necessitate a change in the plans for Chittagong, and as the Bengal Government have again requested me to take up observations at that port as soon as possible, I shall send the set from Moulmein to Chittagong when the current year of observations is complete, which will be about the end of April 1886.

The result of the levelling between Madras and Beypore has been to show that the mean level of the sea at Madras is apparently higher than at Beypore by about 7 inches, that is, the *northern* station is *higher* than the *southern*: again, the levelling which was carried to Bangalore affords a means of comparing the Kárwár and Madras mean sea-levels, and the result shows that they are almost identical. If we take into account the result of the previous season's levelling, which allowed Kurrachee and Bombay mean sea-levels to be compared and shewed Kurrachee *higher* than Bombay by 7 inches (which is again a case of the *northern* station being the *higher*), we have reason to doubt the existence of the illumination error, which had been considered as the possible cause of the discrepancies found in the great lines of levelling between tidal stations. The first 5 great lines of levels which were executed to connect tidal stations indicated in every instance that the sea-level was apparently higher at the southern than at the northern station. It is quite possible that the level of the surface of the sea may be disturbed under the influence of local attractions and be higher at some points of a coast line than at others, but the actual difference of level is only ascertainable approximately by calculations based on various assumptions regarding the constitution of the earth's crust and the surrounding elements of attraction. It cannot be measured, because the attractions have the same influence on the fluid in the bulbs of the levelling instruments as on the waters of the ocean when both are equally exposed to their influence; thus when working along a line of open coast the instrumental level would coincide with the ocean level, and a large deviation from the normal level of the ocean *might* exist without any possibility of measuring it. Thus it seemed that the apparent raising of the southern ends of these lines of levels must be due, not to actual variations in the height of the mean sea, but to some error in the levelling operations. The rigid method of procedure laid down for the levelling ensures the work being carried out with scrupulous care and with every conceivable precaution to guard against gross error or systematic accumulation of minute constant error. General Walker, in writing on this subject, considered there was a source of minute but cumulative error, which, coming from an external quarter, was not guarded against by alternating the direction of operation or by any of the expedients adopted for eliminating inherent cumulative errors. It lay in the tendency there is when levelling an instrument to unduly depress the telescope in the direction of the light which illuminates the spirit-level of the instrument, thus making all objects viewed through the telescope when pointed in that direction appear too high. When the operations are carried on between sunrise and mid-day in India (as has always been the case), the direction of the line of *average* effect of this error would be south-east by north-west, the line of *maximum* effect being meridional; and the error vanishes on the Prime Vertical; but however great the magnitude of the illumination error, it is non-apparent in a circuit of levels, and it is only apparent on a line starting from, and closing on, the mean sea, which affords an independent check on the levelling operations.

The result of the levelling operations between Madras-Beypore, and Kárwár-Madras, as mentioned above, as well as the results found by the levelling between Kurrachee and Bombay, give reason to doubt whether the illumination error really was the cause of the discrepancy between the mean sea at the northern and southern ends of the first five long lines of levels.

In seven out of eight great lines of levels the discrepancies between the value of mean sea as obtained by tidal observations and that determined by levelling brought from another tidal station are very small, not exceeding in any case 2 inches in 100 miles, but there remains the large discrepancy in the Bombay-Madras line of 4¾ inches per 100 miles of line and amounting to 3 feet at the end of the line. The two weakest sections of the line have been re-

levelled, but in each instance with results which are identical with those first obtained. Later on, when the levelling operations are being closed, it may be considered advisable that the remainder of the Bombay-Madras line be re-levelled in the opposite direction to that in which it was done in the first instance, so that the possibility of a gross error having been committed may be effectually settled, and if the observations are errorless in themselves, then I am of opinion that what I stated several years ago as being the cause of the discrepancy must be considered to be the correct explanation, *viz.*, that the error has been introduced by the local attraction encountered on the line which crosses the Western Ghâts and the elevated plateau lying between Bombay and Madras. These attractions would obviously influence the levels of the contiguous instruments in a greater degree than the distant waters of the ocean.

The Marine Survey Department, under Commander Carpenter, R.N., has again been supplied with a considerable amount of information which they required, amongst which may be mentioned complete lists giving the lowest low water of every semi-lunation for each port of every year since the commencement of the observations up to the present time. Thus each diagram from the commencement of the work had to be looked at to pick out the lowest low water on it, and although this was quickly determined on each sheet, yet diagrams amounting to 88 years of observations were so examined, and in most cases each year had 52 diagrams, as one diagram only contained the registration of the tidal curves for one week.

Following the practice adopted in former reports I shall now say a few words regarding the working of each of the tidal observatories, commencing with Aden and Kurrachee, and then taking each station in order round the coast line.

Aden.—The registration of the tidal curves by the self-registering tide-gauge has been most satisfactory. On four occasions only have there been interruptions, and these for a very short time.

The pencil traveller stuck in the tube for one hour on the 15th October 1884. The silver wire attached to the traveller and the counterpoise weight broke twice, *viz.*, on the 19th November 1884 and 12th June 1885 (this is an unimportant occurrence and the repairs are easily carried out), and the float band gave way on the 6th January 1885. The loss of work in no case exceeded a few hours. The clock of the tide-gauge did not once stop during the year. The new anemograph by Messrs. Légé & Co. has worked capitally. Only four short breaks in the registration have occurred. The driving clock stopped three times, and on one occasion the helices failed to mark on the metallic paper of the diagram. A loss of one week's work, however, took place from a mistake of the clerk in not specifying the proper number of diagrams he had ready for use in the statement of stores which he submits monthly, and he ran short before a new supply reached him. A new clock was affixed to the anemograph in December 1884, when Mr. Rendell inspected the observatory.

The new self-registering aneroid by Légé & Co. was started during the inspection in December 1884, and this instrument has been kept in reserve in case the old one breaks down.

In June the cyclone, which was so disastrous to several steamers in the Gulf of Aden, passed over Aden, but fortunately caused no damage to the instruments belonging to the tidal observatory: the tidal disturbances were clearly recorded on the diagram, and barometric pressure, movement of wind and rainfall, were apparently properly registered. Captain Thyne, Port Officer at Aden, continues to give me much assistance by supervising the clerk in charge, and my thanks are due to him for his co-operation in the work.

Kurrachee.—At Kurrachee the work has progressed satisfactorily: however, a number of short interruptions took place on account of the blocking up of the holes near the bottom of the float cylinder by small shell-fish, thus the flow of water into and out of the cylinder was interrupted. Dredging was carried on for a day in the neighbourhood of the cylinder last March, and since then the interruptions have almost entirely ceased, and only on one occasion since that time, *viz.*, 10th August, has there been any trouble on account of the blocking of the inlet holes.

The tidal-gauge clock stopped twice during the past year, but only for a few hours. Mr. Rendell inspected this observatory in November 1884, he found the copper chain (which is attached at one end to the float band and at its other end to the hook under the float) broken, and the float band itself was much worn out. The tide gauge was thoroughly overhauled and cleaned and a new band and chain were substituted for the old ones. Unfortunately, during this inspection the counterpoise weight, which is attached to the end of the float band just above where the copper chain joins the band, had not been fixed high enough on the band; consequently at very high tides this weight reached the bottom of the cylinder and failed to act as a counterpoise against the float, and so turn the stand wheel, thus a few high waters were not properly recorded. The clerk in charge fortunately discovered the cause of the imperfect working of the instrument and moved the counterpoise weight higher up the band. The aneroid clock stopped only once during the year.

The large anemometer belonging to the Port authorities worked all right until the 20th April, when the velocity cups gave way; it was repaired and re-started without much delay.

The tidal disturbance caused by the cyclone in the Gulf of Aden in June 1885 appears to have been felt at Kurrachee, and unusually high tides were recorded soon after the occurrence of the storm at Aden.

I am much indebted to Mr. Price, the Port Engineer, for looking after the clerk in charge of the observatory, and for the interest he takes in the work and I always feel assured that any interruption in the work will be promptly attended to and the necessary repairs made without loss of time.

Bhávnagar.—A special iron cylinder for the float had been obtained from England: it was in sections of 11 or 12 feet in length, and aggregating nearly 50 feet. The internal diameter of this cylinder is over 3½ feet, and there is a special arrangement for connecting the cylinder with a large inlet pipe for the water; there are also steps fixed inside to allow a man to go down and clear away mud or silt which may accumulate at the bottom. There are 4 large iron "lugs" or brackets to be attached to the top of the cylinder to support the platform of the tidal observatory. Thus the observatory is supported entirely by the iron cylinder. I went to Bhávnagar in January to see Mr. Proctor Sims, and arrange for the details of construction: the large cylinder was to be sunk on the bank of the creek at a spot a little below high-water line, and carried down to a depth of some 5 feet below the lowest low water that had been seen: the bottom was then to be plugged with the cement, and a little above the top of the plug the inlet pipe was to be taken from the cylinder through the bank to deep water. The work was exceedingly difficult to carry out, and I was not surprised when I heard in June that they had only succeeded in sinking the cylinder some 40 feet, and that 5 feet yet remained to be done.

I have just received a telegram from the State Engineer telling me the tidal observatory is complete and asking me to send some one to start the observations. A Sub-Surveyor will be sent to Bhávnagar in about a week to commence the observations and teach the clerk in charge his duties; and I shall take an early opportunity of going there or sending the tidal assistant to see that everything is correctly arranged. I am very glad indeed that the work is now so nearly begun, and I fancy there will be no more difficulties now during the period of the observations.

That the difficulties of construction were very great can be easily understood when it is remembered that the rise and fall of the tide at Bhávnagar at the time of new and full moon is nearly 38 feet. The cost of construction must have been considerable, and this, added to the cost of the complete set of tidal instruments, has all been borne by His Highness the Thakore, who has thus given substantial proof of his interest in the work. Mr. Proctor Sims, the State Engineer, has devised all the new arrangements for the erection of the observatory, and it is very gratifying to learn that he has now overcome all the difficulties, and that the observations can be started. I hope this preliminary diagram will have been taken and the instrument properly adjusted before 1st January 1886, so that the observations may be considered as commencing from that date.

Bombay.—The tide-gauge at Apollo Bandar has continued to register most satisfactorily. The clock has again worked without a single stoppage during the year, and except for the breaking of the copper band, and the wire connecting the pencil traveller with the sheave at the float end of the gauge, which occurred on the 7th September, there would have been absolutely continuous registration. As it was, only 8 hours' work was lost.

I inspected the observatory in November 1884, and again later on in February 1885, conjointly with Major Hill, R.E. Subsequently, in May 1885, Mr. Rendell visited the observatory, and the instrument was thoroughly overhauled and cleaned. The clerk at the observatory carries on his duties to my entire satisfaction, and I am indebted to Mr. Ormiston, Port Trust Engineer, for assistance rendered in various ways.

Mormugáo.—The tidal observations at this port have been recorded without any interruption during the whole year. At the beginning of November 1884 Sub-Surveyor Dhondu Venayek, accompanied by the native mechanic, proceeded to Mormugáo, and all the instruments were taken to pieces and thoroughly cleaned. Dhondu Venayek conducted the inspection satisfactorily and re-started the instruments.

The Surveyor-General accompanied by myself paid a flying visit to the observatory on the 21st November, when we found everything working well. Later on, however, in December 1884, and again in May 1885, the anemometer got out of order. One of the wheels of the driving clock was found to be much damaged; the mechanic went down to Mormugáo in June for the necessary repairs, and since then there has been no stoppage.

The self-registering aneroid did not seem to register the fluctuation of the barometric pressure correctly after working for some time, so a new one by Légé and Co. was sent to Mormugáo, and apparently this instrument has given good results.

To Mr. Good, the Executive Engineer in charge of the Harbour works, my best thanks are due for his hearty co-operation in the work.

Beypore.—The observations at Beypore continued to be most satisfactory. Six years' work having been completed this observatory was dismantled on the 14th March 1885, with a view to being set up at Cochin. I proceeded to Beypore and made the necessary inspection previous to removing the instruments. The various measurements to test the zero and the levelling between the bench-mark of reference and the bed-plate, &c., were carried out, and everything was found to be in order. The self-registering tide-gauge had not settled during the whole period of the observations, and the work at this station is most complete and has been carried out to my entire satisfaction. The instruments were sent by steamer to Bombay and then transhipped for London, and are now being altered and modified so as to have all the improvements which I got introduced in the last two sets received from Messrs. Légé & Co. I expect they will be sent out again within the next six weeks, when they will be set up at Cochin. The observatory itself with all its fittings was sent direct by boat to Cochin and is now being erected in the place I selected in November 1884. I discussed the details of the work with the Port Officer at Cochin, and I have no doubt we shall find the observatory ready for the reception of the instruments when they arrive.

The same observatory clerk who was at Beypore will most probably look after the work at Cochin: he is a very competent man.

Colombo.—The tidal registration at this port has not been so satisfactory as I would have wished: there have been a series of interruptions during the past year. The driving clock stopped 5 times and the pencil either stuck or failed to mark on 6 occasions. On the 21st October 1884 the band came off the stud wheel, and the wire between the pencil traveller and the sheave at the float end broke on another occasion. But all the above interruptions were short and did not appreciably affect the continuity of the work, because the hiatus in each case was easily filled up from the collateral curves. There was, however, an interruption of a fortnight in September and October 1884, when the registration was faulty owing to an obstruction in the tube by which the water flowed into and out of the float cylinder. The retardation could not be remedied at once; however, on the first opportunity the clerk had of getting at the nozzle of the tube he cleaned it out and so restored a free communication.

On the 9th December the cylinder was reported to be shifting through the action of the strong current: it was secured in position by being surrounded with heavy stones at the bottom. Since then the only accident which has occurred was the falling away of the nozzle at the end of the tube, which happened in July last, but this was soon renewed. In March of the present year a spring escapement driving clock for the tide-gauge was substituted for the pendulum clock, and for this purpose Sub-Surveyor Dhondu Venayak went to Colombo and made an inspection of the observatory, but in the following month Mr. Rendell inspected this observatory and overhauled and cleaned the tide-gauge. The clock has not stopped once but its rate is very variable.

At the inspection the bottom plate of the float cylinder was found to be much worn away and it was necessary to put on a false bottom from inside. Five holes, one-eighth inch diameter, were bored in the copper funnel, which is at the head of the tube for the inlet of the water; this was done in order to guard against retardation in case the tube got partially blocked.

Captain Donnan, the Master Attendant, takes much interest in the work. At Colombo, the anemometrical and barometrical data are supplied by the office of the Surveyor-General of Ceylon.

Galle.—The tidal observations at this port have been almost continuous and very satisfactory: the driving clock has not stopped once during the year although its rate has been somewhat variable and on two occasions it was as much as 3 minutes in error when compared with telegraph time. This observatory was inspected by Mr. Rendell in April 1885, when all the instruments were cleaned and left in good working order. During the inspection the anemometer was removed from the observatory, which was obviously not a good site for this instrument; it was set up on the top of the signaller's house on the southern rampart, which is a much better place for it. This instrument has failed to work for some time past: the hollow brass tube connecting the upper and lower portions of the instrument was in two pieces, one fitting inside the other to a depth of a couple of inches: in setting up this instrument the one tube had not been sufficiently rammed home into the other, and consequently the upper portion revolved while the lower part remained stationary.

One of the new clocks was substituted for the old one in this anemometer, for, as was reported last year, the clocks supplied in the first instance with the four new instruments were defective. The aneroid barometer did not work well up to the time of the inspection in April 1885, when it was cleaned and set right. But one of the new self-registering aneroids by Légé & Co. was set up at this station as the performance of the old one was not considered reliable.

On the 29th July last the iron cylinder for the float being worn out was removed for repairs, but the observations were resumed on the 4th August, so that the interruption did not last longer than one week.

Captain D. Blyth, Master Attendent, superintends the clerk in charge; he interests himself in the work and has rendered me valuable assistance from time to time.

Negapatam.—I regret to say that the tidal registration at this station has been most unsatisfactory. The clerk has most certainly been reporting simultaneous comparison of the reading of the pencil on the diagram and of the water outside on a graduated staff as being the same when they were quite different: in fact if he took comparisons at all he must have entered information which was incorrect. Thus the daily reports showed nothing which would lead one to suppose that there had been retardation in the flow of water into and out of the cylinder, and the fault was not discovered until the reduction of the observations was completed. The values of the amplitudes and epochs deduced when shewn to me differed so entirely from previous years that I at once saw something was wrong and examined the diagrams. The contracted appearance of the curves was so very marked in many of the diagrams that I was surprised that this circumstance was not brought to my notice when the hourly readings were read off. As it was, I had the year's observations split up into different periods, and roughly analysed with the result that the epochs (κ) of the principal tides were found to occur later and later as the year advanced. Thus it would appear that a gradual silting up had occurred in the vicinity of the observatory which prevented the free flow of the water into and out of the float box. Enquiries were made from the clerk in charge both by the Port Officer and by Mr. Rendell during the inspection, but he declared he had always taken the readings correctly.

In October 1884 a cyclone passed over this port, and the rough weather which followed, combined with the heavy flood in the backwater, damaged the observatory, so much so that the Port Officer removed the instruments to the Marine Office for safety, and they were kept

there until the observatory was put in order again (it had tilted considerably over to one side) and the instruments set up at the end of January 1885. But the observations were quite imperfect, owing to the blocking up of the site all round by sand: eventually on the 20th March a copper pipe, about 11 feet long, was attached to the bottom of the float box and so connected it with tolerably deep water.

Arrangements were also made to prevent retardation by boring a number of inlet holes at the side of the float box close to the bottom. Also to guard against the possibility of the clerk not recording his comparisons properly, the Port Officer was asked to occasionally check these comparisons and also to take readings on another pole on the opposite side of the creek, the zero of which had been determined by levelling with reference to the zero of the tide-gauge. Thus the loss of work is very great at Negapatam, as we cannot consider that the registration was properly re-established till March 1885.

The self-registering aneroid and anemometer worked properly during the whole year under review.

Madras.—The self-registering tide-gauge has worked fairly well. There was one long break in the work, *viz.*, from the 11th to the 28th October, when the driving clock was out of order. Another short break of one day occurred in March last, when the inlet hole to the float pipe got blocked: again on the 24th August it was reported that the heavy traffic on the pier seriously interfered with the proper working of the clock.

On the morning of the 21st November 1884 a cyclone moving northwards passed over Madras and the high water was raised so much that the pencil would have gone beyond the top of the drum if it had been possible for it to do so. Mr. Rendell inspected this observatory in May 1885 and left the instruments in good order. The self-registering aneroid did not work well and had to be constantly attended to by the watch-maker: however, the aneroid observations are not of much consequence in Madras, as the Madras observatory records will be available.

Vizagapatam.—The observations at Vizagapatam continued to be very good up to the time the work was closed in March last. At this station 6 years' work had been secured and Mr. Rendell went there in March to inspect the observatory and take all the final measurements for zero, and to test the connection of bed-plate and bench-marks, &c., prior to removing the instrument. The observatory itself and all its fittings were sent to Cocanada to be erected, while the instruments were sent to Madras and there transhipped for London. The tide-gauge will have all the modifications and alterations done to it by Messrs. Légé & Co., and the self-registering aneroid will also be slightly modified. When the instruments are put into thorough working order they will be sent out to be set up at Cocanada.

The mercurial barometer being in good order was taken by Mr. Rendell to Cocanada, when he went there to look for a site for the observatory.

False Point.—The self-registering tide-gauge at False Point continued to work very well, but in March last, when Mr. Rendell inspected the observatory and connected the bed-plate of the self-registering tide-gauge with the bench-mark of reference on shore, he found that the observatory had settled by 1¼ inches since the previous inspection. This settlement will cause some trouble in treating the diagrams relating to the period between the two inspections, as the settlement must be considered as having occurred gradually. The clock of the self-registering tide-gauge (a pendulum one) having frequently stopped on account of the vibration of the observatory, one of the new spring escapement clocks was fitted up during Mr. Rendell's inspection and the instrument worked capitally afterwards. The new anemometer worked well throughout the year and it was arranged to replace its clock (which had been roughly constructed by the maker) by one of the 4 new anemometer clocks received from Légé & Co., but the new clock had been damaged in transit so it was brought away to be repaired in Poona. The aneroid records from the 3rd October 1884 (when the instrument was accidentally thrown out of adjustment by the clerk) up to the 12th March 1885 are of no use.

But I regret to report that the tidal observatory, with all the instruments and such of the records as remained in the observatory, was carried away by the cyclonic sea wave which passed over False Point on the early morning of the 22nd September 1885. I have as yet been unable to get official information regarding the state of the place now, but from newspaper reports, it is clear that the whole of the buildings at Hookeytola, Custom and Port offices, &c., have disappeared, and with the exception of two persons all the people who were living at Hookeytola have perished.

Captain Douglas, the Port Officer, was amongst the number who lost their lives, as was also the tidal observatory clerk.

The sea wave must have been an exceedingly high one, and was most disastrous, for not only did it carry away the village of Hookeytola, but I understand a great number of other villages along the coast and some distance inland have been destroyed.

I saw Lieutenant Petley, the Deputy Conservator of the River at Calcutta, and as he has to visit False Point with a view to reporting on its state to the Government of Bengal, I have asked him to let me know if the bench-marks on shore at Hookeytola have been left uninjured, and I have already written to the Collector of Customs at Cuttack to issue orders for the protection of the bench-marks. I considered this a necessary precaution, because in rebuilding the houses at False Point, those bench-marks might be injured or even removed by people who would be new to the place and would of course know nothing about them.

By the plan which has now been in force for more than two years the tidal diagrams are despatched in batches every month from each of the tidal stations to Poona, and in this way

very few of the records of tidal registration at False Point have been lost. The last diagram ends on the 24th August, and the last daily report is for the 19th September 1885.

The observatory at False Point was to have been dismantled and the instruments removed in May 1886 as the whole 5 years' series of observations would have been completed, and it is disappointing that the last year's record should be incomplete; but the data already obtained from the False Point observations will suffice, and enable the final value of the tidal co-efficients to be determined very nearly correctly, so that it will be unnecessary to carry on further observations at False Point. The loss incurred by the disappearance of the instruments is of course very considerable, and as they were to have been erected at Chittagong it will now be necessary to get the set from Moulmein when the work is finished at that station, which will be in April next.

I propose arranging to send the Amherst instruments when the current year's observations are complete (about the beginning of August 1886) to Akyab; as it will be unnecessary to carry on further observations at Amherst after that time especially without simultaneous observations at Moulmein.

Dublat.—At this station the work may be considered most satisfactory, for with the exception of five days in October 1884, when the clerk in charge was absent (and his substitute did not attend to his duties properly), and also a seven hours' stoppage of the tide-gauge clock in November, the registration has been continuous. I inspected the observatory in December last and fixed a new spring escapement clock to the self-registering tide-gauge in place of the old pendulum one, which however was left in reserve at Dublat in case of accidents. The performance of the new clock is all that could be desired, and the vibration in the structure on which the observatory is erected does not affect it.

The aneroid and anemometer worked very well throughout, and except the time when the clerk failed to perform his duties properly the registration was continuous.

A new self-registering aneroid by Légé & Co. constructed on different principles was set up however at this station, as the old aneroid was not considered quite reliable as regards its record of the barometric pressure. Four of these instruments had been supplied from the India Office on General Walker's recommendation, and have been placed at Aden, Mormugão, Dublat, and Galle.

Mr. Rendell inspected the observatory in February 1885, and according to my instructions he altered the zero of the gauge to correspond exactly with that of the Kejiri tide pole. The reason for doing so is that Kejiri is one of the most important stations on the river for the Pilots, and being not far off from Dublat, the tide is much the same at both places, so it has been arranged that the tidal predictions for Dublat for height of high water and low water should be given in terms of the zero of Kejiri.

The levelling operations which had been taken along the banks of the Hooghly some three years ago are of immense use to the river surveyors, and in order to meet the wishes of Lieutenant Petley, Deputy Conservator of the river, Mr. Rendell connected each of the tide poles of the river survey with the nearest bench-mark: after having done so for the Kejiri pole, he was enabled to fix the Dublat zero to correspond, and thus a comparison of the actual phases of the tide with the predicted values for Dublat will be done without any calculation in future, as the zero of the tables and of the tide gauge will be the same.

Diamond Harbour.—There have been a great many stoppages of the self-registering tide-gauge clock, but they were all of short duration, and the breaks in the tidal curves will be easily interpolated. Unfortunately we have no spare spring escapement clock such as has recently been fixed to several of the tide-gauges to replace the pendulum clock at this station.

The observatory was inspected by Mr. Rendell in March 1885, when the instrument was cleaned and left in good working order.

At the beginning of August last there had been very heavy freshets in the river, and the observatory at Diamond Harbour gave way and tilted on one side, so much so that Lieutenant Petley, Deputy Conservator of the river, consulted me (as I was in Calcutta) and arranged to have the instruments removed and repairs carried out; Major Hill was communicated with by telegram, and he sent Mr. Belcham at once to Diamond Harbour to see the instruments properly set up again and get the work re-started: this was done by the 31st August. There has been no stoppage of the clock of the self-registering tide-gauge since he left.

Lieutenant Petley co-operates most cordially in the work at the Hooghly stations, and it was only owing to his having sent down a strong party of workmen under a European mechanical engineer that the observatory at Diamond Harbour was so soon put to rights.

Excluding the period mentioned above the anemometer has only had three interruptions in its work, one of which was caused by the breaking of the cup attachments, but these interruptions were only for a few hours on each occasion.

The aneroid has worked well throughout.

The Post Master of Diamond Harbour, who superintends the work at the tidal observatory, has done so to my entire satisfaction, and he has trained a second clerk who has been available for Dublat when required.

Mr. Belcham found that a settlement of over one foot had taken place in the observatory after it had been raised and refixed by Lieutenant Petley's men; he had therefore to adjust the self-registering tide-gauge, so that its zero should correspond with the "true zero" line to which all the heights at Diamond Harbour have been referred; this was done after he had connected the bed-plate with the bench-mark of reference. The shock of the earthquake of the 14th July was distinctly felt at Diamond Harbour, and is recorded on the tidal diagram.

Kidderpore.—The clock of the self-registering tide-gauge has stopped very often during the past year; it is a pendulum one, and the vibration of the observatory is considerable when there is a high wind or a very strong current; and during the freshets last monsoon in the Hooghly the currents have been exceptionally strong. But the interruptions caused by these stoppages are insignificant, being only for an hour or two on each occasion, so the breaks have easily been filled up.

The anemometer has given continuous registration throughout the whole year. The clock of the self-registering aneroid stopped eight times during the year, but the stoppages were all of short duration. The observatory was inspected by Mr. Rendell in March 1885, when all the instruments were cleaned and left in good working order, and again Mr. Belcham inspected the observatory in September last after he had finished his work at Diamond Harbour.

Elephant Point.—The observatory was reported as settling in October 1884, and it was necessary to take immediate steps for preventing this as the main supports were giving way. Mr. Jennings, the Port Engineer, promptly put the work in hand, the instruments were removed and the observatory itself was taken down on the 5th November: and on the 8th December the necessary repairs had been completed and the observations were resumed.

From December till the middle of July the registration was satisfactory, for although the clock stopped several times, yet the breaks were each of very short duration, and the hiatus in the tidal curves was easily interpolated.

In January last the telegraphic time got at Elephant Point was reported as unreliable, and I addressed the Director-General of Telegraphs on the subject who issued instructions to the Telegraph authorities in Burma to give me the assistance asked for.

In June the self-registering tide-gauge diagram was injured by rats. In July the clerk reported the band as coming off the stud wheel and also that the jetty at the end of which the observatory is built was sinking; the matter was reported to the Port Engineer. Later on, the float box was reported to be out of the perpendicular, and on seven or eight occasions in July and August the chain at the end of the float band stuck in the box.

On the 1st September the observatory was raised to its original level without having to remove the instruments, and the float box was properly repaired.

The diagrams for July and August will give some trouble in preparing for the measurements.

The self-registering aneroid and self-registering anemometer have worked very well throughout.

I visited this observatory in January 1885 in company with the Port Engineer, and Sub-Surveyor Dhondu Veneyek was left with the native mechanic to have all the instruments thoroughly overhauled and cleaned.

Mr. Rendell inspected Elephant Point observatory shortly afterwards and found all the instruments working well. On this occasion the zero of the gauge was altered so as to be as nearly as possible on the level of the lowest recorded low water, and this has been accepted by the River Surveyor as the datum to which the soundings on his chart will be referred.

My acknowledgments are due to Mr. Darlington for assistance rendered at various times, and especially to Mr. Jennings, the Port Engineer, who promptly carried out the repairs which were necessary at Elephant Point.

Rangoon.—Except for a week at the end of July when the clock of the self-registering tide-gauge had to be sent to the watch-maker for repair, there have been no interruptions in the registration worth mentioning.

The vibration of the wharf on which the observatory is built, caused by the rolling of heavy bales of goods and boxes, &c., occasionally stops the clock, but the breaks are always for a very short time.

The diagram on the tide-gauge was damaged by rats on the 20th September.

The self-registering aneroid has given much trouble and its clock has been frequently stopping.

The anemometer also has not worked well; its velocity gear got out of adjustment; and altogether the performances of this instrument have been unsatisfactory.

I inspected the observatory in January, and at that time I discussed with the Port authorities the question of the datum line to which the soundings on the river charts should be referred, and we arranged to alter the zero of the self-registering tide-gauge to the datum line which was to be adopted. Details of this will be found in the preface to the Rangoon tide tables for 1886. Accordingly, later on, when Mr. Rendell inspected the observatory, he took the necessary levels and connected the bed-plate of the self-registering tide-gauge with the zero of the graduated pole on the Brooking Street wharf, and then altered the zero of the self-registering tide-gauge.

A standard bench-mark has been laid down in the vicinity of the tidal observatory and a suitable inscription will be cut on it giving the height above the mean level of the river for the whole period of the observations, the height above the datum line for soundings on the chart, and also the heights above the highest recorded high water and the lowest recorded low water.

Amherst.—There have been several interruptions in the working of this observatory. Mr. Rendell inspected this station in January 1885 and left everything in good order. In April, the action of the stop-cock on the pipe connecting the bottom of the cylinder with deep water was imperfect owing to two holes in the piping: the cause was discovered in May and at once repaired, but this necessitated a stoppage of work for five days. On the 16th June the bi-monthly flushing of the cylinder to carry away the silt which is deposited at the bottom of the cylinder could not be carried out owing to a leakage: this was discovered on the 25th

July. Again from the 8th to the 12th August the pipes were under repair, and on the 26th of the same month the float band broke, but a new one was substituted on the same day. But the driving clock only stopped once during the whole year.

The anemometer registration was continuous, but the clerk reported about three months ago that the velocity gear was out of order from the rain finding its way into the small box at the top of the instrument

The aneroid has worked uninterruptedly since Mr. Rendell's inspection in February 1885.

Moulmein.—The tidal observations have been almost continuous since October 1884, the clock of the self-registering tide-gauge having only stopped once during the whole period: this was owing to a substitution of a spring escapement clock for the pendulum one in January last, which was necessary on account of the vibration of the wharf on which the observatory is built. The rain somewhat spoilt one diagram; this was reported on the 2nd May. The new anemometer which had been set up in January 1884 worked without a single stoppage but when Mr. Rendell inspected the observatory in January he fixed a new clock to this instrument, to replace the one first in use which was faulty in construction, and since then the registration has been continuous.

The aneroid too has worked without any interruption, but this instrument (as well as the mercurial barometer) has been set up in the Master Attendant's office, so that it is not subjected to the vibrations of the observatory.

I am greatly indebted to Captain Dodd, the Master Attendant, for supervising the work both at Moulmein and Amherst, for without his assistance the work at the latter station would often have been at a standstill.

Port Blair.—Since the resumption of the observations on the 1st November 1884, after the cylinder had been repaired, the registration may be said to have been continuous, for the only interruptions were from the float band sticking for a very short time on three different occasions. The cylinder again required repair on the 11th August, but the registration was not stopped on that account.

I inspected the observatory in December 1884, and found it necessary to re-arrange many of the fittings which had not been carefully attended to when re-starting the observations. A portion of the bed-plate of the self-registering tide-gauge had to be cut away to admit of the float band moving without hindrance. The cylinder had not been replaced perpendicularly; an attempt was made to put this right, but it was feared that the application of much force would make it bulge out: consequently the self-registering tide-gauge was moved on its trestle so as to permit the float working without any chance of the band catching. The anemometer has worked most satisfactorily and its record is continuous.

The aneroid has also worked without any interruption. In taking this instrument to pieces during my inspection, the native mechanic found two lizards of considerable size inside the aneroid box; they must have been there for some length of time, as from their size it was impossible for them to get out by the key-hole by which they must have entered. All the instruments in the observatory were cleaned and left in good order before I left and there has been no break in the registration since that time.

LEVELLING OPERATIONS.

The programme laid down for the season was as follows, *viz.*, to carry a line of levels from Madras along the railway to Beypore, and on its completion to return to Jalárpet junction and carry a line thence, also along the railway, to Bangalore. During the execution of these lines of levels, all trigonometrical stations lying within a convenient distance were to be connected by branch lines, and, in addition to the bench-marks usually laid down, others called "test bench-marks" were to be embedded near the tidal observatories at Madras and Beypore.

The first camp was formed at Perambúr railway station, but owing to incessant rain no observing could be done till the 15th November; during the interval, however, the instruments were all examined and cleaned and two "test bench-marks" were embedded, one in the Carnatic Mill compound and the other in the verandah of the police station at Sembian village, each being about a mile from and on opposite sides of the Perambúr railway station.

The first section of the work, Madras-Arkónam, practically verified the similar section done in 1880-81, the difference of level between the bench-marks at Madras and Arkónam coming out the same within a few thousandths of a foot. It might have been considered unnecessary to start from Madras instead of Arkónam, but on account of the discrepancy in the mean sea of Bombay and Madras, as obtained by levelling, it is very desirable to take every opportunity of revising any portion of the line so long as it can be done without seriously interfering with the regular work.

From Arkónam the levels were carried through Arcot and Vellore to Jalárpet railway station (the junction of the Bangalore line), and thence through Salem, Erode, Pódanúr, and Pálghat to Beypore tidal observatory. This completed the first part of the programme; it comprised 407 miles of levelling along the main line, and another 16 miles in running branch lines to the 4 trigonometrical stations noted in the margin and to the two "test bench-marks" embedded on the hill near Kuttipuram railway station, about 18 miles east of Beypore tidal observatory.

Anandalamalai, H. S.
Salem railway station, S.
Mordr, H. S.
Chennimalai, H. S.

Regarding the closing of his work at Beypore Mr. Belcham writes:—

"Before the party reached Beypore, I was summoned thither by Major Baird, who instructed me how the connection of the bench-marks across the Beypore river could best be effected; his instructions were fully

carried out, and I succeeded in completing the line to Beypore by the end of March, or in about 3½ months' time. This section closed on bench-mark A at the tidal observatory at Beypore with only a difference of 0·629 foot showing the very small error in the levelling of 0·00155 foot per mile."

The party then proceeded to Jalárpet junction, and starting from the bench-mark laid down some two months before, the line of levels was carried along the railway to Bangalore, and thence to the south-west end station of the Bangalore base line; this section was 86 miles in length, and in addition 23 miles of levelling had to be executed to connect the following Great Trigonometrical Survey stations, *viz.*, Yerrakonda hill station, Tirthapalli hill station and north-east end station of Bangalore base line.

The section really closed on a bench-mark at the *mantapam* (temple) near the south-west end of the base line laid down by the levelling party in 1874-75. The difference between the value of this point above mean sea Madras and its value above mean sea Kárwár as obtained by levelling is 0·038 foot; which result shows the mean sea at Madras and Kárwár to be identical by the levelling operations between the two tidal observatories.

Having stored most of the camp equipment in the office of the Mysore Topographical Survey Party, Mr. Belcham proceeded with the levels and staves, &c., taking the greater number of the men with him to Madras to connect the "test bench-marks" laid down by him near Perambúr railway station at the beginning of the season.

These "test bench-marks" some distance inland from a tidal station are being fixed so that in case of any local alteration of level in the vicinity of the tidal station it will be possible at some future date to determine what has happened. Similar bench-marks were laid down inland from Beypore tidal station.

A standard bench-mark for Madras has been cut on the plinth of the light-house, and suitable inscriptions have been cut on the sides of the large block of stone forming the portion of the plinth on which the bench-mark has been cut. The Government of Madras passed a Resolution on the subject, and the work has been carried out in accordance with what was authorised by Government.

Similarly a standard bench-mark has been laid down at the Public Works Secretariat in Bombay, in accordance with the Resolution of the Bombay Government. It consists of a block of stone 3 feet cube resting on a masonry foundation: the top of the stone will be the plane of reference, and suitable inscriptions have been cut on its sides. The top of this stone corresponds exactly with 100 feet above Town Hall datum. This was an important consideration as most of the levels in Bombay are given in terms of Town Hall datum. Another standard bench mark was laid down at the entrance of the Prince's Dock, at the request of Government. The levelling in connection with the above had to be very carefully done, and was taken from the tidal observatory to the Town Hall, and also to the Public Works Secretariat and to the Prince's Dock; this was carried out by Mr. Belcham and Narsing Dass.

The levelling operations during the season were carried out strictly in accordance with the rigorous method which obtains in this Department and all the lines were executed by double levelling.

Bench-marks, consisting of blocks of stone 18″ × 12″ × 12″, have as usual been fixed, in masonry pillars, at intervals of from 8 to 15 miles; they have all been embedded in railway station compounds, near some permanent building, so that there may be no difficulty in their future identification. In addition to the above, other bench-marks have been inscribed on the parapets of railway bridges, on railway platforms, and on all well-defined rocks on the slopes of railway cuttings, and a large number of bench-marks belonging to the Railway Department have been connected.

The health of the party was not at all good during the first two months, during which time the rain fell often for 5 and 6 days together: on this subject I quote from Mr. Belcham's report as follows:—

"Some very feverish tracts were passed between Jalárpet and Salem, especially along the eastern slopes of the Shevaroy hills. Two or three of the railway stations are considered to be so unhealthy that the working staff only remains there for the day; they come to their duty bringing food and water with them by the first train in the morning and return to Salem by the last local train in the afternoon. I had been told of the unhealthiness of the tract of country, so that encamping grounds had to be judiciously selected, and I had to endeavour to get through it as expeditiously as possible; fortunately we had several cloudy days which I took advantage of by keeping out the whole day; by this means we frequently covered double the ground usually gone over in one day, which not only helped us to get over this insalubrious tract rapidly and with but few cases of fever, but also made up for the delays we experienced in the beginning of the season, when we caught the full benefit of the north-east monsoon."

Mr. Belcham acknowledges the very great assistance he obtained from the District Engineers of the Madras Railway and from various railway officials.

Mr. Belcham reports most favourably of Narsing Dass, his coadjutor in the levelling, and he also says Ganesh Sudasheo and Balwant Atmaram, the two recorders, worked very well.

As I have previously stated, the total out-turn, 533 miles, is the largest ever yet done in one season by one levelling party: and although the total rises and falls are not so great as in the previous season's work yet they are considerable. The large out-turn is therefore due to the excellent work of the levellers, both of whom have now had great experience.

Regarding the state of the north-east station of the Bangalore base line, Mr. Belcham writes:—

"Before concluding, I have to bring to your notice that I was not able to connect the ground-level mark at the north-east station of the Bangalore base, as it had been destroyed. On visiting the observatory I found the doors and windows opened out, and the pyramidal stone denoting the end of the measured base dug out and

broken, the covering stones cut in segments were all scattered about and broken; I however connected the ⊙ circle and dot on the roof of the observatory. The rest of the trigonometrical stations connected during the season were all in good preservation."

A statement showing the out-turn of work is appended.

Tabular statement of out-turn of work for the Field season 1884-85 by the Levelling Party under Mr. Belcham.

During the month of	Number of miles Double Levelling.		Total number of feet.		Number of bench-marks embedded, inscribed and connected.				
	Main Line.	Branch Line.	Falls.	Rises.	Embedded.	Inscribed.	Public Works Department.	Railway.	G. T. Survey stations.
	Ms. Chs. Lks.	Ms. Chs. Lks.	Feet.	Feet.		No.	No.	No.	No.
November 1884	41 35 42	... ...	66·2	305·1	...	22	...	4	...
December ,,	91 49 82	4 29 8	165·2	1576·8	7	39	...	36	1
January 1885	100 37 41	... ...	1559·6	1036·4	8	38	...	39	1
February ,,	83 48 50	10 45 37	1434·0	2923·1	7	21	...	46	2
March ,,	90 12 59	1 19 38	993·2	167·4	12	27	...	45	...
April ,,	81 36 94	9 71 72	986·7	365·1	8	30	...	34	2
May ,,	4 23 82	13 21 62	303·6	454·9	5	10	...	2	2
Total	493 4 41	39 27 37	5489·5	10519·8	47	187	...	206	8
Total number of miles of double levelling		532 31 78	Total of falls and rises.	16009·3 feet.					

Revision of Heights of the Khánpisura and Singi Series.

The programme for the season comprised observations for the revision of heights of the four stations of the Khánpisura Series, left unvisited during the previous season, and the revision of heights on that part of the Singi Series comprised between the initial base Párner-Singi and the side Tarbhan-Dopari.

The party under Mr. H. E. T. Keelan assembled at Jalgaon railway station on the 17th November and marched to Argaon H. S. the nearest hill station of the Khánpisura Series at which observations had yet to be taken. Argaon H. S. was reached on the 20th November and the observations were completed on the 22nd of that month.

The next station, Ajnád H. S., was reached on the 25th, and the work was finished there on the 28th November. Some delay occurred at this station on account of the inattention of the signaller at Anakvádi H. S.

On account of the nature of the country and there being no direct road to Bábákuvar H. S. a detour had to be made and the work at this station was not completed till the 3rd December.

The observations at Jalálabad H. S. the last station of the Khánpisura Series, were finished on the 9th December. The party then marched to Jalgaon railway station and railed to Ahmednagar, in the neighbourhood of which the work on the Singi Series commenced.

Regarding the marches from Jalgaon railway station to his nearest trigonometrical station, and back again to Jalgaon when the Khánpisura Series was completed, Mr. Keelan writes :—

"The Tápti river had to be crossed twice and as there were no boats to be had where our route touched the river, on each occasion a whole day was lost making the frail rafts do duty for regular ferry boats, and by having to employ them the tents and other parts of the luggage got slightly damaged by being submerged in the discoloured water of the river.

"The three stations of Ajnád, Bábákuvar and Jalálabad are situated in a very wild part of the country on either side of the boundary between Khándesh and Sendwa (Holkar State) districts, and the short time, about 16 days, the party marched and camped about the forest tracts between those hills was sufficient to develop a mild type of jungle fever amongst its members as well as amongst the camp followers, several dropping every day on the return march with more or less severe attacks. Fortunately I was able in most cases to subdue the fever in from two to three days by administering full doses of Eno's fruit salt and of Quinine during the intermissions, and by the time I arrived at Jalgaon railway station nearly all the sick were quite well or fairly convalescent. The men on detached duty seemed to suffer most; but out of some twenty-five cases of fever one khalasi only was so much debilitated as to have to take his discharge and return home."

Mr. Keelan was now stopped by heavy rain and completely "overcast skies" which prevented anything being done till the 31st December. The camp then moved to the foot of the hill on which Agargaon H. S. is situated.

The Agargaon-Párner ray of the Bombay Longitudinal Series had to be observed before proceeding to Párner, the first station of the Singi Series.

Mr. Keelan was unable to see Párner H. S. from Agargaon: in November 1883 it was found that when observing at this station from a platform 16½ feet high the heliotrope at Párner could not be seen. Mr. Keelan reports that only the flat tops of two hills (one to the north-west, 10 miles distant, and the other to the south-west by west about 16 miles away) could be seen; either of these would have answered as a subsidiary station, but the one hill could not be seen from Párner H. S. owing to the trees over a Mahomedan shrine which the keepers would not allow to be touched, and the other hill which was visible at both stations was a grazing ray from Agargaon.

Mr. Keelan then adopted the plan of fixing a point on the Agargaon-Párner ray at a point on the high ridge of the plateau from which both stations could be seen. A small triangulation was carried on from a measured base to connect the point with Agargaon H. S. and the required reciprocal angles were observed to obtain the difference of height Agargaon-Párner.

Mr. Keelan now marched to Párner H. S. of the Singi Series, and the observations were completed on the 11th January at that station: there had been a short delay on account of the signal at Kalsúbái H. S., 60 miles distant, not showing up till the afternoon of the 11th January. The camp then marched to Singi H. S: the platform of this station was repaired but no heliotrope could be seen owing to the haze till the 18th January. On the 19th the observations were completed.

Hewargaon H. S. was next visited, and the work there was completed on the 28th January. Sinnar H. S. was reached on the 2nd February, and the observations having been completed on the 4th, Kalsúbái H. S. was visited and the work finished at that station on the 9th February.

Mr. Keelan was then obliged to halt for three days owing to an attack of fever which commenced at Kalsúbái H. S., on the summit of which he had to remain a night and where he reports the cold as having been intense.

Kámandrug was reached on the 19th February, but a dense haze had set in. Quoting now from Mr. Keelan's report:—

"This haze rose soon after sunrise every morning, apparently moving from the sea towards the Ghâts, and rising gradually till by 11 A.M. only a few peaks remained above the haze looking like islands in a murky sea. By noon even the peaks became enveloped and nothing at a distance could be seen for the rest of the day. Whilst on Kalsúbái hill this haze was watched, it appeared as a great dull white bank below Kámandrug peak, and stretching away to the north as far as Gambírgarh H. S., with the higher peaks however remaining visible the whole day. Believing that a similar state of things would prevail when at Kámandrug, I did not expect any unusual delay; but after the second day, without any work being done, I despatched messengers to all the signallers with instructions to look for flashes from my station immediately after sunrise (and not as heretofore about noon) when the haze lying low the distant hills can be seen and they could adjust their lines early in the morning, keep them adjusted so as to turn on the sun at 1 P.M., and to keep steadily showing till 4 P.M.. This method answered well with the two points Kalsúbái and Gambírgarh (each over 51 miles away), the heliotropes showing through the haze like points of light, but the third and remaining station, Singi, 55 miles away, remained obstinately invisible, and not being able to account for it, the peak being well seen in the early morning, I sent off the *mukaddam* (headman) by train on the 25th to show me a signal as soon as he could, and to ascertain the cause of the signaller's negligence there. The *mukaddam's* heliotrope was seen in the early morning of the 27th, and during the afternoon the signal was observed too through the dense haze, thus completing the work at this station. On the return of the *mukaddam* I learnt from him that the signaller and his assistant were not at their post, and no one could tell him where they had gone to. This man, however, turned up while the work was going on at the next station, Gambírgarh, and reported that the morning after the messenger I had sent to him had reached he was ascending the hill in order to reach the station by sunrise, when he was attacked by a party of Bhils, who after maltreating him severely took away most of his clothing and all the money he had. Being left without means for procuring his daily food he started the same day for the nearest station to seek help of the signaller before coming on to my camp. Whether there was any truth in his story or not I was never able to ascertain, but by the desertion of his post I was delayed at Kámandrug about four or five days."

Gambírgarh H. S. was not visited till the 6th March on account of the nature of the country to be marched over; the observations were completed by the 10th, a delay having occurred on account of the signaller at Pilwa H. S. not being able to find the hill, of the whereabouts of which the Bhils gave him no information.

Mr. Keelan writes—

"This point of Pilwa stands in the midst of a wilderness known as the Surgána Dáng; the country is very rugged and hilly, the villages few and far between, connected by pathways only, the inhabitants a rather wild and shy specimen of the Bhil tribe, averse to giving information, or having much to do with strangers; their villages are composed of huts scattered by ones and twos over a circle, often of 2 miles in diameter, and nothing like the ordinary collection of huts known as a village in more civilized tracts: thus it would be at all times difficult for strangers to find their way about without some loss of time amidst such surroundings."

Párner H. S. was reached on the 15th March. The ray to Tarbhán station was blocked with trees, the tops of which along the ray had to be cut; the observations were finished on the 22nd March.

Mr. Keelan had difficulty about carriage in proceeding to Pilwa H. S. in the Dángs, which was eventually reached on the 25th March. A delay again occurred from the signaller not being able at first to find Dopári H. S., no village or hill named Dopári existing anywhere in the neighbourhood. Observations were completed at Pilwa on the 31st March.

Mr. Keelan then reports:—

"From Pilwa I marched to Tarbhán (the only station not situated on a hill) and reached it on the 3rd April. I found the platform and station mark built over by a dome-shaped mound of masonry, 3 feet high in the centre, and sloping away to the margins of the circular platform, with a dot and circle cut on its summit. As the instrument could not be set up on this structure, it had to be removed before observations could be commenced. The work was completed here on the 7th instant.

"Tarbhán station was the northernmost point of the Singi Series which had to be revised. The stations on the eastern flank as far as Ankai H. S. had still to be visited and observed at, so from Tarbhán station I had to make for Dopári H. S., the northernmost point of the eastern flank, and thence turn down by Sáler H. S. and Ankai H. S. closing on Bhorgad H. S. the centre of the second polygon. The programme of work as I first laid it out was, after completing observations at Gambírgarh H. S. to march to Bhorgad H. S., and then to Ankai H. S., and so on round the third polygon closing the work at Párner H. S.; but in the beginning of March, and whilst on the march to Gambírgarh H. S., I learnt that an epidemic of cholera of a bad type had broken out at Násik and Trimbak which are close to Bhorgad H. S. To avoid any risk therefore to the camp people I had to alter the remaining portion of the programme so as to visit those localities last, in hopes that by that time the epidemic would have abated considerably or disappeared altogether; and such proved to be the

case, for when the party marched into that part of the Násik district the disease in an epidemic form had entirely ceased."

Mr. Keelan arrived at Dopári H. S. on the 13th April and finished his observations on the 14th. Great difficulty was then experienced in reaching Sáler H. S. through the nearly trackless forest country which intervened. Sáler H. S. is about 3,000 feet higher than Dopári H. S.; it was reached on the 21st and the observations were finished on the 22nd. Ankai H. S. was reached on the 27th and work was completed there on the 30th. The platform at this station was in such a bad state that the whole structure had to be rebuilt before the theodolite could be set up.

Bhorgad H. S. was reached on the 6th May, but owing to the signaller at Pilwa H. S. deserting his post and a substitute having to be sent there, the observations were not completed till the 12th May. This completed the revision of heights of the Singi Series, and Mr. Keelan then marched to Násik and railed to Poona.

All the stations visited were covered over after the observations were completed, and handed over to the charge of the village authorities.

Fifteen stations were observed at; the total length of the series observed over was 165 miles, and its breadth 95 miles. The distance marched by the party was 660 miles.

I consider Mr. Keelan performed his duties in a very creditable manner.

REDUCTION OF THE OBSERVATIONS AND COMPUTATIONS CARRIED ON IN THE HEAD-QUARTERS OFFICE, POONA.

The work performed in the office during the past year as regards computations, &c., is highly satisfactory, for although the reduction of current observations is somewhat in arrears yet a vast amount of extra work has been accomplished in the shape of computing the four new tidal co-efficients (compound tides) introduced by Professor Darwin, for all the years of observation at each station since the commencement of the work.

Since the date of last report one year's observations have of course been taken at 19 stations, but the observations at only 15 stations have been reduced and the results for 14 stations will be discussed in this report. The reductions of the Negapatam observations are useless.

This shows arrears of one year's observations at 4 stations, but it should be stated that a good deal of the computations for the 15 years' work now reduced was well forward on the date of last report; and similarly the computations for a new batch of reductions of one year's observations at 18 stations are at present well begun.

On the other hand the calculations of the four new co-efficients have been made for two, three, or more years, at 19 stations, making a total aggregate of 51 years reduced. The computations are going on very steadily under Mr. Connor, and if there is no extra work thrown on the office I trust he will be able to bring the reductions more nearly up to date when the next Annual Report is submitted than they are at present. When I say up to date I consider that every station at which a current year of observation has been completed three months before the date of submitting my Annual Report should have the results included in the report.

The following is the state of the work in progress :—

Aden 1884-85	Summations of series ready.
Kurrachee „	Additions of hourly heights of each series ready.
Bombay 1885	Year incomplete, so the readings from the diagrams are not read off.
Mormugão 1885-86	
Colombo „	
Galle „	
Negapatam „	
Madras 1884-85	Additions of hourly heights of each series in hand.
Vizagapatam „	
False Point „	
Dublat 1884-85	The hourly readings being copied from the S. series into the other series.
Diamond Harbour „	
Kidderpore „	
Rangoon „	
Elephant Point 1884	Summations of series ready.
Moulmein 1884-85	Diagrams ready but the hourly readings not yet complete.
Amherst „	
Port Blair „	

It will be easy by comparing the above with the state of the work next October to see the amount of work which has actually been executed. The reductions have been carried out strictly in accordance with the method laid down by Professor Darwin, to facilitate which, auxiliary tables were drawn up by me as reported last year. I ought to mention that the long period tides are now being calculated in accordance with Professor Darwin's Report: at first the forms sent out gave some trouble in one or two instances. I wrote to England on the subject, and some foot-notes were printed at my request, otherwise the forms would have been misleading.

I am glad to say the new method is much quicker and neater than the old plan and the results are identical, for I tried one year's work at two different stations by both plans and got exactly the same results. Regarding the importance of the results already obtained from the tidal observations in India in a scientific point of view, the following extracts from the address

of General Walker, C.B., late Surveyor-General, when President of the Geographical Section of the British Association, at the recent meeting in Aberdeen, are interesting :—

"While on the subject of the constitution of the earth's crust, I may draw attention to the circumstance that the tidal observations which have been carried on at a number of points on the coasts of India, as a part of the operations of the survey, tend to show that the earth is solid to its core, and that the geological hypothesis of a fluid interior is untenable. They have been analysed by Professor G. H. Darwin with a view to the determination of a numerical estimate of the rigidity of the earth, and he has ascertained that whilst there is some evidence of a tidal yielding of the earth's mass, that yielding is certainly small, and the effective rigidity is very considerable, not so great as that of steel as was at first surmised, but sufficient to afford an important confirmation of the justice of Sir William Thomson's conclusion as to the great rigidity."

Reverting again to the tidal operations in India, in his address, General Walker says :—

"The initiation of the later and more elaborate operations is due in great measure to the recommendations of the Tidal Committee of the British Association, of which Sir William Thomson was President. The tidal observations have been treated by the method of harmonic analysis advocated by the Committee. The constants for amplitude and epoch are determined for every tidal component, both of long and of short periods, and with their aid, tide tables are now prepared and published annually for each of the principal ports; and further it is with them that Professor G. H. Darwin made the investigations of the effective rigidity of the earth, which I have already mentioned. The very remarkable waves which were caused by the earthquake on December 31st, 1881, in the Bay of Bengal, and by the notable volcanic eruptions in the island of Katakatoa and the Straits of Sunda on August 27th and 28th, 1883, were registered at several of the tidal stations and thus valuable evidence has been furnished of the velocities of both the earth-wave and the ocean-wave which are generated by such disturbances of the ordinarily quiescent condition of the earth's crust."

The Tide Tables.

As I said before, the 1886 tables will contain the predicted heights and times of high water and low water for 23 ports.

The values of the constants are now sent to Mr. Robert ready for use, so that he knew the proper throw of the crank and the angle to which it had to be set for O hours January 1st, 1886, in setting each "co-efficient" wheel on the tide-predicting machine. These constants have been computed as follows.

For each year at each port there is a value of H the "mean" amplitude and of κ the "mean" epoch for each tidal constituent: these H's and κ's have been averaged for each series, and the mean taken in each case as the actual value for the particular station; and then according to the rules laid down in Professor Darwin's report, the amplitudes R and epoch ζ for the beginning of the required year to be used in the tide predictor have been calculated.

Instead of averaging the H's and κ's as stated above, the proper way would have been to calculate the most probable values and the probable errors, but we have as yet not found time to do this; the values used are however obviously very nearly correct.

Regarding the method employed for the riverain tides, I would beg to refer to the preface to the 1886 Tide Tables at the several riverain ports. I should mention that the special volume for the Hooghly Ports has been much appreciated, and Lieutenant Petley informs me he had to have another 500 copies struck off: 1,000 copies of this book have been ordered for 1886 by the Port Commissioners, and the vast amount of information contributed by Lieutenant Petley, R.N., in this publication has added immensely to its value.

As usual I append a statement showing the percentage of the errors, in time and height, of the predicted high and low waters at the various stations for the year 1884, as compared with the actuals measured from the diagrams, and arranged according to different amounts of error.

No. 1.

Statement showing the Percentage and the amount of the errors in the Predicted Times of High Water at the various Tidal Stations for the year 1884.

Station.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	707	68	31	1	0	0
Kurrachee	707	35	41	12	10	2
Bombay	708	44	42	8	5	1
Beypore	708	15	27	14	23	21
Madras	519	83	16	1	0	0
Vizagapatam	707	33	44	10	9	4
False Point	707	27	36	33	15	9
Port Blair	606	39	43	8	7	3
Dublat	695	29	39	11	15	6
Diamond Harbour	708	27	36	15	14	8
Kidderpore	707	25	37	16	16	6
Rangoon	707	23	35	12	21	9
Amherst	707	46	23	12	13	6
Moulmein	632	19	33	16	19	13

No. 2.

Errors in the Predicted times of Low Water.

Station.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	707	69	29	1	1	0
Kurrachee	707	46	38	9	6	1
Bombay	707	35	41	14	8	2
Beypore	707	12	24	12	19	33
Madras	519	82	16	2	0	0
Vizagapatam	707	31	40	11	12	6
False Point	707	32	37	10	11	10
Port Blair	605	37	41	11	10	1
Dublat	696	34	38	12	13	3
Diamond Harbour	707	27	33	15	19	6
Kidderpore	707	22	42	12	16	8
Rangoon	708	24	35	14	18	9
Amherst	707	44	24	14	12	6
Moulmein	633	37	39	9	9	6

No. 3.

Statement showing the percentage and the amount of the errors in the Predicted Heights of High Water at the various Tidal Stations for the year 1884.

Station.	Number of comparisons between the actual and predicted values.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
		Per cent.	Per cent.	Per cent.	Per cent.
Aden	707	88	12	0	0
Kurrachee	707	82	17	1	0
Bombay	708	72	22	5	1
Beypore	708	81	17	1	1
Madras	519	93	7	0	0
Vizagapatam	707	64	30	5	1
False Point	707	82	13	4	1
Port Blair	606	96	4	0	0
Dublat	695	58	30	10	2
Diamond Harbour	708	50	31	12	7
Kidderpore	707	37	28	19	16
Rangoon	707	50	31	13	6
Amherst	707	50	28	13	9
Moulmein	632	31	30	22	17

No. 4.

Errors in the Predicted Heights of Low Water.

Station.	Number of comparisons between the actual and predicted values.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
		Per cent.	Per cent.	Per cent.	Per cent.
Aden	707	87	13	0	0
Kurrachee	707	74	22	4	0
Bombay	707	70	26	4	0
Beypore	707	57	35	6	2
Madras	519	92	7	1	0
Vizagapatam	707	62	32	5	1
False Point	707	82	14	3	1
Port Blair	605	98	2	0	0
Dublat	696	55	31	11	3
Diamond Harbour	707	42	30	18	10
Kidderpore	707	31	25	22	22
Rangoon	708	30	33	23	14
Amherst	707	23	17	18	42
Moulmein	633	43	35	13	9

VALUES OF THE TIDAL CONSTANTS, KURRACHEE, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Kurrachee; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations :—

Short-Period Tides.

A_0=7·192 feet.

S_1 H=R=	0·074	M_6 R=	0·055	Q_1 R=	0·112	T_2 R=	.
$\kappa=\zeta=$	171°·24	$\zeta=$	150°·05	$\zeta=$	175°·59	$\zeta=$	.
S_2 H=R=	0·952	H=	0·050	H=	0·133	H=	.
$\kappa=\zeta=$	328°·70	$\kappa=$	206°·21	$\kappa=$	43°·15	$\kappa=$	.
S_4 H=R=	0·010	M_8 R=	0·005	L_2 R=	0·055	$(MS)_4$ R=	0·033
$\kappa=\zeta=$	25°·26	$\zeta=$	1°·33	$\zeta=$	22°·10	$\zeta=$	197°·45
S_6 H=R=	0·006	H=	0·005	H=	0·053	H=	0·032
$\kappa=\zeta=$	279°·90	$\kappa=$	196°·20	$\kappa=$	284°·98	$\kappa=$	336°·17
S_8 H=R=	0·002	O_1 R=	0·558	N_2 R=	0·607	$(2SM)_2$ R=	0·029
$\kappa=\zeta=$	288°·44	$\zeta=$	226°·64	$\zeta=$	93°·35	$\zeta=$	230°·19
		H=	0·662	H=	0·588	H=	0·028
		$\kappa=$	48°·21	$\kappa=$	278°·05	$\kappa=$	91°·48
M_1 R=	0·108	K_1 R=	1·177	λ_2 R=	0·006	$2N_2$ R=	0·114
$\zeta=$	26°·00	$\zeta=$	92°·82	$\zeta=$	54°·46	$\zeta=$	10°·43
H=	0·081	H=	1·301	H=	0·006	H=	0·110
$\kappa=$	31°·39	$\kappa=$	47°·08	$\kappa=$	281°·57	$\kappa=$	241°·12
M_2 R=	2·649	K_2 R=	0·238	ν_2 R=	0·029	$(M_2N)_4$ R=	0·043
$\zeta=$	155°·22	$\zeta=$	233°·95	$\zeta=$	100°·60	$\zeta=$	87°·05
H=	2·566	H=	0·304	H=	0·028	H=	0·040
$\kappa=$	293°·93	$\kappa=$	321°·64	$\kappa=$	330°·92	$\kappa=$	50°·48
M_3 R=	0·030	P_1 R=	0·392	μ_2 R=	0·068	$(M_2K_1)_3$ R=	0·064
$\zeta=$	159°·12	$\zeta=$	357°·23	$\zeta=$	358°·89	$\zeta=$	11°·94
H=	0·029	H=	0·392	H=	0·064	H=	0·068
$\kappa=$	347°·20	$\kappa=$	48°·34	$\kappa=$	276°·33	$\kappa=$	104°·92
M_4 R=	0·036	J_1 R=	0·096	R_2 R=	.	$(2M_2K_2)_3$ R=	0·027
$\zeta=$	98°·63	$\zeta=$	147°·04	$\zeta=$	.	$\zeta=$	59°·74
H=	0·033	H=	0·111	H=	.	H=	0·028
$\kappa=$	16°·07	$\kappa=$	58°·20	$\kappa=$	.	$\kappa=$	22°·92

Long-Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·024	84°·00	0·022	38°·01
„ Fortnightly „ . . .	0·040	25 ·62	0·058	341 ·20
Luni-Solar „ „ . . .	0·011	286 ·88	0·011	148 ·16
Solar-Annual „ . . .	0·088	359 ·82	0·088	38 ·71
„ Semi-Annual „ . . .	0·189	92 ·16	0·189	169 ·94

The mean level of the sea is for this year 7·192 feet above the zero of the gauge, which is higher than the value for the 2 previous years, but lower than the value obtained in each of the 4 years preceding. By plotting the values of mean sea at Kurrachee on section paper, having a vertical scale of 1 division $=\frac{1}{100}$ of a foot and 3 divisions horizontally for each year, I obtain a curve which has a most regular appearance, with the maximum and minimum heights at the top and bottom and at about 9½ years apart.

The main lunar tide has an amplitude of 2·566 feet, which is the greatest value yet obtained at Kurrachee, but only differs from the 1882-83 value by 0·008 foot.

The epoch of the main lunar tide is very accordant with the 3 previous years' values; it differs from the mean of the 3 previous years only by 0°·48 or under 1 minute in time.

The main solar tide on the other hand is less in amplitude than the value obtained for the 4 preceding years, being 0·952 foot, but it only differs from the greatest value ever obtained at Kurrachee (in 1880-81) by 0·017 foot.

The epoch of the main solar tide agrees very well with last year's value, and also with those for the 5 years immediately preceding.

The main solar tide is 0·371 of the main lunar tide; theoretically it should be 0·465, but the proportion for the present year at Kurrachee, although less than what has been observed

for the 4 previous years, nevertheless fairly agrees with what has been generally found at Kurrachee.

The luni-solar semi-diurnal tide has almost the same proportion to the main lunar tide as the theoretical value; last year it was only 9 per cent. instead of 13 per cent. of the Main Tide; but except in 1880-81 (when the observations were partially taken by the old and partially by the new gauge) when the value of this tide was over 16 per cent. of the Main Tide, I notice that every 4th year the luni-solar semi-diurnal tide at Kurrachee is 9 per cent. while for the other years it is 11 or 12 per cent. of the Main Tide.

The larger lunar elliptic tide (N_2) is 23 per cent. of the Main Tide, while the smaller (L_2) is 2 per cent.: these values are found generally to obtain at Kurrachee; the theoretical values are 19 and 3 per cent. respectively.

The larger evectional tide (ν_2) is only 1 per cent. of the Main Tide; it should be 4 per cent. theoretically, and at Kurrachee it has generally been found to vary from 3 to 4 per cent. It is to be remarked that 9 years previous the value of 1 per cent. of the Main Tide was also found to obtain.

The smaller evectional tide (λ_2) is insignificant, as it ought to be.

The lunar elliptic tide of the 2nd order ($2N_2$) is 4 per cent. of the Main Tide; theoretically it should be 0·026 of the main tide.

The variational tide (μ_2) agrees with the theoretical value in its proportion to the Main Tide, and this has usually been found the case.

The principal diurnal tide (K_1) is 51 per cent. of the Main Tide, and this is exactly what has been found usually at Kurrachee; the theoretical proportion is 58 per cent.

The lunar declinational tide (O_1) is 26 per cent. of the Main Tide, and this is in accordance with former values at Kurrachee; the theoretical proportion is 42 per cent.

The solar declinational tide (P_1) is 15 per cent. of the Main Tide; theoretically it should be 19 per cent., but the proportion got for the present year agrees well with former values at Kurrachee.

The remaining diurnal tides (Q_1, J_1, M_1, and S_1) are 5, 4, 3, and 3 per cent. respectively of the Main Tide, and are fairly accordant with the proportions found in former years; the theoretical proportions are 8 per cent. for the solar elliptic (Q_1), 3 per cent. for the lunar elliptic (J_1), nearly 4 per cent. for the lunar diurnal (M_1), and there is no theoretical value for the tide (S_1).

The overtides are all very small at Kurrachee, as in former years; the largest is the sexter-diurnal lunar (M_6), which is nearly 2 per cent. of the Main Tide as usual.

With regard to the long-period tides, the lunar monthly is less than 1 per cent. of the Main Tide; usually it is about 2 per cent.; theoretically it should be 4½ per cent. of the Main Tide.

The lunar fortnightly is 0·023 of the main lunar tide: for the last 4 years it had less than half that value; the theoretical proportion is 0·086.

The luni-solar fortnightly is quite insignificant, as it ought to be.

The solar annual tide is ·034 of the Main Tide, and agrees fairly well with the proportion obtained in the 3 previous years.

The semi-annual tide is ·074 of the Main Tide, about double what it was last year, and this is the highest value since 1873-74.

Of the compound tides the ter-diurnal (M_2K_1) is the greatest, being ·027 of the Main Tide.

Regarding the epochs of the various tides. For O_1 and K_1 they agree well with former values; for K_2 and P_1 this may also be said to be the case. For J_1 the epoch is considerably different from that obtained last year, but this tide seems to vary at Kurrachee very considerably in its epoch. For Q_1 the epoch is very different from that obtained last year, but this tide too varies considerably in its epoch at Kurrachee. For the tide N_2 the epoch is very fairly accordant with all the former values at Kurrachee.

The tides λ_2, ν_2, and μ_2 always vary a good deal in their epochs at Kurrachee.

The lunar monthly and fortnightly tides and the luni-solar fortnightly have always very divergent values for their epochs.

The solar annual tide has its epoch for this year 39° nearly, *i.e.*, its maximum would be about the end of April, which is some 12 days earlier than in the two previous years, but previous to that the usual time was about the 21st June.

The epoch of the solar semi-annual is fairly accordant with former values, and its times or maxima at Kurrachee would appear to be 16th June and 16th December.

VALUES OF THE TIDAL CONSTANTS, BOMBAY, 1884.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884 observations at Bombay; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884 observations:—

Short Period Tides.

A_0=10·256 feet.

S_1	H = R =	0·059	M_6	R =	0·612	Q_1	R =	0·121	T_2	R =	...
	κ = ζ =	173°·14		ζ =	282°·47		ζ =	234°·48		ζ =	...
S_2	H = R =	1·636		H =	0·011		H =	0·147		H =	...
	κ = ζ =	1°·48		κ =	58°·13		κ =	49°·41		κ =	...
S_4	H = R =	0·007	M_8	R =	0·010	L_2	R =	0·091	$(MS)_4$	R =	0·142
	κ = ζ =	359°·18		ζ =	295°·93		ζ =	313°·96		ζ =	96°·58
S_6	H = R =	0·008		H =	0·008		H =	0·079		H =	0·137
	κ = R =	169°·05		κ =	356°·81		κ =	328°·33		κ =	21°·80
S_8	H = R =	0·003	O_1	R =	0·554	N_2	R =	1·013	$(2SM)_2$	R =	0·051
	κ = ξ =	123°·69		ζ =	318°·51		ζ =	301°·69		ζ =	38°·11
				H =	0·676		H =	0·978		H =	0·049
				κ =	48°·16		κ =	312°·19		κ =	112°·89
M_1	R =	0·121	K_2	R =	1·247	λ_2	R =	0·017	$2N_2$	R =	0·147
	ζ =	130°·05		ζ =	211°·21		ζ =	235°·28		ζ =	202°·72
	H =	0·125		H =	1·401		H =	0·017		H =	0·142
	κ =	54°·86		κ =	44°·90		κ =	141°·25		κ =	298°·50
M_2	R =	4·216	K_2	R =	0·331	ν_2	R =	0·150	$(M_2N)_4$	R =	0·075
	ζ =	43°·16		ζ =	144°·31		ζ =	137°·05		=	22°·28
	H =	4·071		H =	0·435		H =	0·145		H =	0·070
	κ =	328°·38		κ =	351°·07		κ =	261°·53		κ =	318°·00
M_3	R =	0·068	P_1	R =	0·416	μ_2	R =	0·196	$(M_2K_1)_3$	R =	0·028
	ζ =	137°·52		ζ =	234°·19		ζ =	97°·66		ζ =	315°·75
	H =	0·064		H =	0·416		H =	0·183		H =	0·030
	κ =	25°·35		κ =	43°·84		κ =	308°·10		κ =	74°·66
M_4	R =	0·135	J_1	R =	0·120	R_2	R =	...	$(2M_2K_1)_3$	R =	0·077
	ζ =	109°·24		ζ =	301°·68		ζ =	...		ζ =	38°·54
	H =	0·126		H =	0·143		H =	...		H =	0·080
	κ =	319°·68		κ =	51°·97		κ =	...		κ =	55°·29

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·038	108°·46	0·034	23°·18
„ Fortnightly „	0·030	76 ·92	0·046	2 ·84
Luni-Solar „ „	0·055	112 ·18	0·053	186 ·96
Solar-Annual „	0·062	46 ·13	0·062	326 ·49
„ Semi-Annual „	0·099	8 ·50	0·099	209 ·22

The mean level of the sea (A_0) is 10·256 feet above the zero of the gauge, which corresponds almost precisely to the value obtained in 1883. The values in 1883 and 1884 are about $\frac{8}{100}$ths of a foot above the mean of the whole 7 years' observations.

The mean amplitude of the main lunar tide (H of M_2) is 4·071 feet; this is the greatest value yet obtained at Bombay, but does not materially differ from the 1880 value. The average value of the amplitude of this tide for the whole 7 years of Bombay is 4·041 feet. The epoch (κ) of the main lunar tide only differs by about 0°·5 from last year's value. In fact, the values obtained for the epoch of this tide at Bombay are very accordant throughout the whole 7 years of observations. The greatest discrepancy between any two years being 2°·28 or less than 5 minutes in time.

The amplitude of the main solar tide (H of S_2) is also greater for this year than for any of the previous years at Bombay, being 1·636 feet, but it does not materially differ from the value in 1879. The epoch of this tide is 1°·48, which is the least value yet obtained at Bombay and differs from the greatest value (that of 1882) by 2°·31, or less than 5 minutes in time. The

proportion of the amplitude of the main solar tide to the main lunar tide is ·402; theoretically it should be ·465, but the proportion now obtained is very accordant with the values hitherto found at Bombay.

The luni-solar semi-diurnal tide (K_2) is for this year about 11 per cent. of the Main Tide; in former years it was generally found to be 10 per cent.; theoretically it should be 13 per cent. The epoch of this tide (κ of K_2) is 351°, which is fairly accordant with the values found in former years.

The larger component (N_2) of the lunar elliptic semi-diurnal tide is ·240 of the Main Tide; theoretically it should be ·194, but this tide has always been found at Bombay to be 5 or 6 per cent. greater than the theoretical value. The epoch of this tide is 312°, which agrees fairly well with the two preceding years' values, but does not materially differ from the mean value of the whole seven years.

The smaller component (L_2) of the lunar elliptic semi-diurnal tide is 2 per cent. of the Main Tide. Last year this tide was found to be very insignificant; theoretically it is only 3 per cent. of the Main Tide, and the values obtained during the seven years of Bombay vary between 3 and 1 per cent.

With regard to the evectional semi-diurnal tides, the larger component (ν_2) agrees very closely, in its proportion to the Main Tide, with the value which theory would assign, while in the two previous years its value was nearly twice as great as it ought to be. The smaller component (λ_2) is quite insignificant, which theory shows ought to be the case, and this has always been found to obtain at Bombay.

With regard to the lunar elliptic tide of the second order ($2N_2$), the value obtained this year is about 1 per cent. greater than the theoretical value, while last year the value agreed very closely with theory.

The variational semi-diurnal tide (μ_2) is twice as great as it ought to be; this has always been found to be the case at Bombay.

With regard to the diurnal tides, they are as a rule smaller in proportion to the Main Tide than the theoretical values; but this has always been found to be the case at Bombay; however, the values obtained this year are very accordant with those of former years.

The following shows the proportions of the principal diurnal tides to the Main Tide as obtained at Bombay for the year 1884, compared to the values which theory would assign—

	1884	Theoretical.
Luni-solar (K_1)	·344	·584
Lunar (M_1)	·031	·036
Solar declinational (P_1)	·102	·193
Lunar declinational (O_1)	·166	·415
Lunar elliptic (J_1)	·035	·033
Solar elliptic (Q_1)	·036	·080

With the exception of M_1, J_1, and Q_1, the epochs (κ) of the diurnal tides agree well year by year, and their values may be considered as having been fairly well determined; but for the 3 tides named, the epochs vary as follows; for the M_1 tide between 18° and 105°; for the J_1 tide between 40° and 89°; and for the Q_1, tide between 45° and 60°.

Regarding the overtides at Bombay, those of any importance are the ter-diurnal lunar (M_3), which is ·016 of the Main Tide, and the quarter-diurnal lunar which is ·031 of the main lunar tide, values which agree very well with those obtained last year.

With regard to the long-period tides the lunar monthly and the lunar fortnightly as well as the luni-solar fortnightly are each about 1 per cent. of the Main Tide, values which agree fairly well with those obtained last year; but the lunar monthly tide should be theoretically 5 per cent. of the Main Tide, and the lunar fortnightly ought to be 9 per cent.

The solar annual tide seems to vary considerably in amplitude at Bombay: this year it is nearly 2 per cent. of the Main Tide, last year it was less than 1 per cent., while in 1878 it was considerably over 6 per cent. The epoch of this tide for this year is 326°, but there are great discrepancies in the values of the epoch of this tide at Bombay in the whole 7 years. The time of maximum would appear to vary between the 6th of January and 16th of March.

Regarding the solar semi-annual tide its proportion to the Main Tide for this year is ·024: theoretically it should be ·049, while the value obtained last year was almost a theoretical proportion. The epoch of this tide at Bombay appears to vary between 162° and 232°, which gives the times of maxima to be between the 11th June and 16th July and the 11th December and 16th January. This would appear to show that the tide has its maximum values about the beginning of the S.-W. and N.-E. monsoons and that the tide is meteorological in origin.

VALUES OF THE TIDAL CONSTANTS, MORMUGAO, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Mormugão; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations.

Short Period Tides.

A_0=5·512 feet.

S_1	H—R=	0·080	M_6	R=	0·011	Q_1	R=	0·081	T_2	R=	·
	κ—ζ=	157°·27		ζ=	211°·37		ζ=	250°·51		ζ=	·
S_2	H—R=	0·638		H=	0·010		H=	0·099		H=	·
	κ—ζ=	336°·75		κ=	260°·96		κ=	64°·02		κ=	·
S_4	H—R=	0·008	M_8	R=	0·014	L_2	R=	0·035	$(MS)_4$	R=	0·023
	κ—ζ=	108°·91		ζ=	78°·31		ζ=	59°·29		ζ=	163°·20
S_6	H—R=	0·003		H=	0·012		H=	0·030		H=	0·022
	κ—ζ=	119°·75		κ=	24°·42		κ=	306°·67		κ=	59°·73
S_8	H—R=	0·003	O_1	R=	0·421	N_2	R=	0·443	$(2SM)_2$	R=	0·002
	κ—ζ=	94°·57		ζ=	64°·96		ζ=	205°·06		ζ=	97°·77
				H=	0·516		H=	0·427		H=	0·002
				κ=	53°·03		κ=	287°·03		κ=	201°·24
M_1	R=	0·039	K_1	R=	0·904	λ_2	R=	0·011	$2N_2$	R=	0·064
	ζ=	355°·60		ζ=	141°·13		ζ=	317°·23		ζ=	331°·48
	H=	0·045		H=	1·020		H=	0·011		H=	0·062
	κ=	97°·69		κ=	48°·07		κ=	323°·22		κ=	238°·89
M_2	R=	1·831	K_2	R=	0·138	ν_2	R=	0·159	$(M_2N)_4$	R=	0·048
	ζ=	48°·67		ζ=	330°·63		κ=	311°·09		ζ=	4°·48
	H=	1·766		H=	0·182		H=	0·153		H=	0·045
	κ=	305°·20		κ=	324°·00		κ=	278°·16		κ=	342°·97
M_3	R=	0·019	P_1	R=	0·300	μ_2	R=	0·067	$(M_2K_1)_3$	R=	0·017
	ζ=	282°·88		ζ=	313°·67		ζ=	94°·42		ζ=	172°·02
	H=	0·018		H=	0·300		H=	0·062		H=	0·019
	κ=	307°·67		κ=	49°·40		κ=	247°·48		κ=	335°·49
M_4	R=	0·044	J_1	R=	0·051	R_2	R=	·	$(2M_2K_1)_3$	R=	0·009
	ζ=	227°·52		ζ=	319°·74		ζ=	·		ζ=	104°·85
	H=	0·041		H=	0·061		H=	·		H=	0·009
	κ=	20°·58		κ=	42°·76		κ=	·		κ=	350°·96

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·054	260°·17	0·048	74°·73
„ Fortnightly „	0·031	273 ·47	0·048	13 ·85
Luni-Solar „ „	0·022	47 ·52	0·021	150 ·99
Solar-Annual „	0·306	313 ·09	0·306	307 ·36
„ Semi-Annual „	0·075	174 ·01	0·075	162 ·57

The value of A_0, the mean level of the sea, is 5·512 feet above the zero of the gauge.

The mean amplitude (H) of the main lunar tide is 1·766 feet, which is only about two-hundredths of a foot greater than the value obtained during the 5 years' observations at Kárwár. The epoch of this tide, as deduced from the present year's observations, is 3½° greater than the mean value obtained from the five years at Kárwár, which shows that this tide attains its highest range at Mormugáo 7 minutes after Kárwár.

The main solar tide (S_2) is 0·361 of the Main Tide, and this proportion agrees very closely to the mean proportion obtained during the 5 years at Kárwár, which is very much less than the theoretical proportion 0·465. The epoch of this tide is 336°·75; the mean epoch at Kárwár was found to be 334°·7, so that this tide at Mormugáo reaches its maximum height 4 minutes after the time of its maximum at Kárwár.

The principal component (N_2) of the lunar elliptic tides is 24 per cent. of the Main Tide; theoretically it should be 19 per cent. At Kárwár the proportion of this tide to the Main Tide was 23½ per cent., or very nearly the same as the proportion now found at Mormugáo. The epoch of this tide deduced from the present year's observations is about 5½° (or 11 minutes in time) later than the mean value found at Kárwár.

The lesser component (L_2) of the lunar elliptic tides is 0·017 of the Main Tide; theoretically it should be 0·028; at Kárwár it was found to be 0·033 of the Main Tide.

The evectional tide (ν_2) is 0·087 of the Main Tide, which is more than twice as great as it ought to be. At Kárwár the proportion of this tide to the Main Tide was 0·050, which is also slightly larger than the theoretical proportion ·038.

The smaller evectional tide (λ_2) has the same proportion to the Main Tide as the theoretical proportion, and is quite insignificant.

The lunar elliptic tide of the second order ($2N_2$) is ·035 of the Main Tide; theoretically it should be ·026.

The variational tide (μ_2) is also ·035 of the Main Tide, whereas its theoretical proportion is ·024.

With regard to the diurnal tides, the main component, the luni-solar diurnal (K_1), has exactly the same proportion to the Main Tide as the theoretical proportion, *viz.*, 58 per cent., and this was also found to be the case at Kárwár.

The lunar declinational tide (O_1) is 29 per cent. of the Main Tide; theoretically it should be 42 per cent.; at Kárwár this tide was found to be 28½ per cent. of the Main Tide.

The solar declinational tide (P_1) is 17 per cent. of the Main Tide; at Kárwár it was 16 per cent., and theoretically it is 19 per cent.

The solar elliptic tide (Q_1) is about 6 per cent. of the Main Tide; at Kárwár it was almost 7 per cent. and theoretically it should be 8 per cent.

The lunar elliptic tide (J_1) is ·035 of the Main Tide, which is slightly less than the average proportion at Kárwár, but agrees very closely to the theoretical proportion.

The lunar diurnal tide (M_1) is ·025 of the Main Tide, theoretically it should be ·036; but at Kárwár it was even smaller, being only about ·019 of the Main Tide.

The epochs of the diurnal tides are from 6 to 14 minutes later than they are at Kárwár.

The only significant overtide at Mormugáo is the lunar quarter-diurnal (M_4), which is ·023 of the Main Tide; at Kárwár this overtide was about ·032 of the Main Tide.

The lunar monthly tide and the lunar fortnightly tide are each ·027 of the Main Tide; according to theory they should be ·046 and ·086 respectively of the Main Tide; but at Kárwár these tides had almost the same value as has now been obtained at Mormugáo.

The luni-solar fortnightly tide is ·012 of the Main Tide, which is about the same value as was found at Kárwár: theoretically this tide is quite insignificant.

The solar annual tide is 17 per cent. of the Main Tide; at Kárwár it varied from 9 to 28 per cent. The epoch of this tide at Mormugáo for the year under review is 307°·4, which would make the time of maximum about the 23rd January; at Kárwár it was found to vary from the 19th January to the 6th February.

The solar semi-annual tide is ·042 of the Main Tide; at Kárwár this tide varied from ·019 to ·073 of the Main Tide. The epoch of this tide at Mormugáo is 162½°, which would make the times of maximum about 10th June and 10th December; at Kárwár the epoch varied between the 25th June and the 17th August.

VALUES OF THE TIDAL CONSTANTS, BEYPORE, 1883-84

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Beypore; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short Period Tides.

A_0=5·301 feet.

S_1	H=R=	0·048	M_6	R=	0·015	Q_1	R=	0·074	T_2	R=	0·061
	κ=ζ=	171°·77		ζ=	222°·22		ζ=	136°·15		ζ=	345°·78
S_2	H=R=	0·350		H=	0·013		H=	0·091		H=	0·061
	κ=ζ=	11°·32		κ=	106°·13		κ=	62°·43		κ=	16°·94
S_4	H=R=	0·007	M_8	R=	0·010	L_2	R=	0·032	$(MS)_4$	R=	0·015
	κ=ζ=	128°·40		ζ=	313°·12		ζ=	357°·27		ζ=	99°·14
S_6	H=R=	0·009		H=	0·009		H=	0·028		H=	0·015
	κ=ζ=	244°·94		κ=	158°·34		κ=	1°·88		κ=	60°·44
S_8	H=R=	0·003	O_1	R=	0·297	N_2	R=	0·229	$(2SM)_2$	R=	0·004
	κ=ζ=	95°·91		ζ=	259°·76		ζ=	204°·65		ζ=	321°·84
				H=	0·362		H=	0·221		H=	0·004
				κ=	55°·64		κ=	296°·36		κ=	0°·54
M_1	R=	0·055	K_1	R=	0·650	λ_2	R=	0·002	$2N_2$	R=	0·020
	ζ=	121°·90		ζ=	244°·76		ζ=	301°·43		ζ=	20°·83
	H=	0·055		H=	0·730		H=	0·002		H=	0·019
	κ=	60°·51		κ=	48°·17		κ=	252°·58		κ=	242°·94
M_2	R=	1·035	K_2	R=	0·080	ν_2	R=	0·003	$(M_2N)_4$	R=	0·017
	ζ=	2°·21		ζ=	213°·83		ζ=	223°·67		ζ=	344°·87
	H=	0·999		H=	0·105		H=	0·003		H=	0·016
	κ=	323°·52		κ=	359°·99		κ=	15°·13		κ=	37°·88
M_3	R=	0·008	P_1	R=	0·230	μ_2	R=	0·010	$(M_2K_1)_3$	R=	0·003
	ζ=	257°·01		ζ=	211°·27		ζ=	346°·30		ζ=	209°·98
	H=	0·008		H=	0·230		H=	0·009		H=	0·003
	κ=	198°·96		κ=	51°·48		κ=	269°·00		κ=	334°·69
M_4	R=	0·029	J_1	R=	0·062	R_2	R=	0·013	$(2M_2K_1)_3$	R=	0·004
	ζ=	99°·91		ζ=	358°·79		ζ=	337°·81		ζ=	14°·04
	H=	0·027		H=	0·073		H=	0·013		H=	0·004
	κ=	22°·52		κ=	33°·80		κ=	126°·16		κ=	133°·24

Long Period Tides.

	R	ζ °	H	κ
Lunar Monthly Tide	0·035	274°·62	0·031	144°·22
„ Fortnightly „	0·035	328 ·80	0·054	158 ·34
Luni-Solar „ „	0·038	163 ·07	0·037	201 ·77
Solar-Annual „	0·308	51 ·00	0·308	360 ·79
„ Semi-Annual „	0·113	68 ·68	0·113	208 ·26

The value of the mean level of the sea (A_0) is 5·301 feet above the zero of the gauges, which is the lowest value yet obtained at Beypore; it differs from the last 3 years' values by a tenth of a foot, and almost by the same amount from the two first years' values. The mean of all the 6 years' observations is 5·383 feet above the zero of the gauge.

The mean amplitude (H) of the main lunar tide is almost precisely 1 foot, which is the same value as was found last year. In the first 3 years' observations at Beypore this tide was found to have an amplitude of ·960 of a foot, and in the fourth year it was ·950; thus the two last values are considerably the highest. There was a considerable variation in the epoch of this tide at Beypore in the 6 years' values, *viz.*, 9½° or 19 minutes in time.

With regard to the main solar tide, the amplitude is ·350, and, except last year (when the amplitude was found to be ·359), this is the highest value yet obtained, the lowest value being ·308. There is a much greater fluctuation in the values of the epoch of this tide at Beypore than is found at other ports, *viz.*, 10°·4 or over 20 minutes in time.

With regard to the lunar elliptic tides, the larger component (N_2) is 0·221, and the smaller component (L_2) is ·028 of the Main Tide; these proportions agree very fairly well with what has generally been found at Beypore, and are practically the same as the theoretical proportions, *viz.*, ·194 and ·028. The epoch of the principal component (N_2) is fairly determined at Beypore, the greatest discrepancy between any two of the 6 years being somewhat over 12°, but the epoch of the lesser component (L_2) has not been so well determined.

The two evectional tides this year are perfectly insignificant. The lesser one (λ_2) should be so theoretically, and this has generally been found to be the case at Beypore, but the larger component (ν_2) varied from ·04 to ·10 of the Main Tide in the first 5 years' observations.

The luni-solar semidiurnal tide (K_2) is ·105 of the Main Tide, which is the highest proportion yet obtained at Beypore, although less than the theoretical proportion ·127. The epoch of this tide varies by 17° in the 6 years of observations.

The lunar elliptic tide of the 2nd order ($2N_2$), which last year was reduced for the first time, has an amplitude of ·019 for the present year; last year's value was ·021, while the theoretical proportion is ·026.

With regard to the diurnal tides, the principal one (K_1) is 73 per cent. of the Main Tide, which is the same as last year's proportion; in the six values for the different years of observation the proportion varies from 73 per cent. to 78 per cent. of the Main Tide; theoretically it should be 58 per cent. Except at Aden this diurnal tide (the luni-solar) at Beypore has a greater proportion to the Main Tide than is found at any other port in India. The epoch of this tide has been very well determined, the greatest discrepancy between any two of the 6 years' values being 7°.

With regard to the remaining diurnal tides the proportions to the Main Tide as a rule agree very well with what has been observed in former years at Beypore.

The following shows the proportion of the diurnal tides to the Main Tide for 1883-84 at Beypore, as well as the theoretical proportion :—

	1883-84.	Theoretical.
The Lunar Declinational (O_1)	0·362	·415
„ Solar do. (P_1)	·230	·193
„ Solar Elliptic (Q_1)	·091	·080
„ Lunar Do. (J_1)	·073	·033
„ Lunar (M_1)	·055	·036

Thus it will be seen that except the lunar declinational tide all the other diurnal tides are proportionally greater, as compared to the Main Tide, than the values which theory would give. The epochs of the Tides K_1, O_1, P_1 are very accordant in all the 6 years at Beypore. There is a discrepancy of 15¼° between the greatest and the least values of the epoch of the solar elliptic tide (Q_1) at Beypore. The epoch of the lunar elliptic tide (J_1) has not been well determined, and this is also the case with the lunar diurnal tide (M_1).

The only significant overtide at Beypore is the lunar quarter-diurnal, which is ·027 of the Main Tide, which agrees with the proportions found for former years. The epoch of this tide is fairly well determined at Beypore.

With regard to the long-period tides, the lunar monthly is 3 per cent. of the Main Tide. The proportions obtained in former years are very divergent, and this year's value is much less than any of the five former values, which vary from 15 per cent. to 6 per cent. of the Main Tide. The epoch of this tide has not been well determined.

The lunar fortnightly tide is 5 per cent. of the Main Tide; this tide at Beypore seems to vary from 12 per cent. to 3 per cent. of the Main Tide: its epoch has not been well determined.

The luni-solar fortnightly tide is 0·037 of the Main Tide, a proportion which is fairly accordant with the values for the 4 preceding years, but is only one-half of the 1878-79 proportion: theoretically this tide is very insignificant. Thus the presence of this tide seems to be well established at Beypore, but its epoch has not been well determined.

The solar annual tide is 31 per cent. of the Main Tide, which is in accordance with what has been found for the last 5 years: the epoch this year is very much the same as was found last year, and the time of maximum of this tide at Beypore would appear to be between the 20th January and the 20th February.

The solar semi-annual tide is ·113 of the Main Tide for this year, which is the lowest proportion yet obtained at Beypore; this tide appears to vary from 28 per cent. to 11 per cent. of the Main Tide, and its epoch seems to vary from 181° to 226° which would give the times of maximum between the 20th June and 12th July and between the 20th September and 12th October.

VALUES OF THE TIDAL CONSTANTS, COLOMBO, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Colombo; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations:—

Short Period Tides.

A_0=2·208 feet.

S_1	H=R=	0·018	M_6	R =	0·002	Q_1	R =	0·024	T_2	R =	·
	κ = ζ =	61°·68		ζ =	46°·85		ζ =	16°·14		ζ =	·
S_2	H=R=	0·362		H =	0·002		H =	0·029		H =	·
	κ = ζ =	99°·60		κ =	76°·27		κ =	80°·79		κ =	·
S_4	H=R=	0·004	M_8	R =	0·000	L_2	R =	0·032	$(MS)_4$	R =	0·005
	κ = ζ =	211°·50		ζ =	135°·00		ζ =	29°·32		ζ =	8°·47
S_6	H=R=	0·002		H =	0·000		H =	0·028		H =	0·005
	κ = ζ =	188°·53		κ =	54°·23		κ =	53°·79		κ =	258°·28
S_8	H=R=	0·001	O_1	R =	0·076	N_2	R =	0·065	$(2SM)_2$	R =	0·009
	κ = ζ =	236°·31		ζ =	40°·17		ζ =	98°·21		ζ =	169°·76
				H =	0·093		H =	0·063		H =	0·008
				κ =	64°·30		κ =	28°·53		κ =	279°·95
M_1	R =	0·008	K_1	R =	0·210	λ_2	R =	0·025	$2N_2$	R =	0·011
	ζ =	144°·89		ζ =	171°·78		ζ =	197°·92		ζ =	80°·11
	H =	0 008		H =	0·237		H =	0·024		H =	0·011
	κ =	56°·56		κ =	35°·72		κ =	59°·07		κ =	50°·96
M_2	R =	0·566	K_2	R =	0·055	ν_2	R =	0·024	$(M_2N)_4$	R =	0·033
	ζ =	162°·97		ζ =	201°·66		ζ =	301°·01		ζ =	72°·31
	H =	0 546		H =	0·052		H =	0·023		H =	0·031
	κ =	52°·78		κ =	108°·98		κ =	39°·47		κ =	252°·45
M_3	R =	0·016	P_1	R =	0·082	μ_2	R =	0·021	$(M_2K_1)_3$	R =	0·004
	ζ =	334°·78		ζ =	254°·94		ζ =	326°·01		ζ =	40°·60
	H =	0·015		H =	0·082		H =	0·020		H =	0·004
	κ =	169°·49		κ =	34°·05		κ =	105°·63		κ =	154°·35
M_4	R =	0·016	J_1	R =	0·025	R_2	R =	·	$(2M_1K_1)_3$	R =	0·005
	ζ =	40°·15		ζ =	211°·79		ζ =	·		ζ =	266°·27
	H =	0·015		H =	0·030		H =	·		H =	0·005
	κ =	179°·76		κ =	36°·95		κ =	·		κ =	181°·94

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·048	58°·91	0·043	18°·39
„ Fortnightly „	0·021	299·33	0·033	220·88
Luni-Solar „ „	0·014	285·77	0·014	35·96
Solar-Annual „	0·328	357·85	0·328	308·75
„ Semi-Annual „	0·123	226·60	0·123	128·39

The mean level of the sea (A_0) is 2·208 feet above the zero of the gauge.

The mean amplitude (H) of the main lunar tide is 0·546 foot; at Pámban the mean value was 0·584. The epoch of this tide at Colombo is for this year 52°·8, while the average value obtained at Pámban during the 4 years was 47°, which shows that this tide attains its maximum at Pámban about 11½ minutes earlier than at Colombo.

The main solar tide (S_2) is 0·663 of the main lunar tide; theoretically it should only be 0·465, but at Pámban this tide is also very much greater than it ought to be in all the 4 years of observations, its average proportion (0·635) being very much the same as now found at Colombo. The epoch of this tide at Colombo from this year's observations is 99°·6, while at Pámban the average value of the epoch is about 92°; this shows that the time of maximum of the main solar tide is over 15 minutes earlier at Pámban than at Colombo. But in these comparisons the epochs are given in terms of the local time at Pámban and Colombo; if we take into account the difference of longitude (Colombo being 0°·38′ east of Pámban), the main lunar tide reaches Colombo 9 minutes after Pámban and the main solar tide 13 minutes.

From the above it seems to be perfectly established that the "make of the tide" at Pámban is from the east, that is from the Bay of Bengal side.

The larger component (N_2) of the lunar elliptic tide is 12 per cent. of the Main Tide; theoretically it should be 19 per cent.; at Pámban it was found to be about 14 per cent. The epoch of this tide is 28°·5; at Pámban it was found to be about 30°·8.

The lesser component (I_2) is about twice as large as it ought to be by theory; at Pámban the proportion was not quite so great.

The luni-solar semi-diurnal tide (K_2) is 13 per cent. of the Main Tide; this is the theoretical proportion. At Pámban it varied from 18 to 21 per cent. of the Main Tide. The epoch of this tide at Colombo is about 109°, whereas at Pámban it is about 90°, or this tide reaches Pámban 38 minutes before Colombo.

The evectional tides (ν_2) and (λ_2) are respectively ·042 and ·044 of the Main Tide; the former proportion is in accordance with theory, but the latter proportion is altogether too great, as the smaller evectional tide should be quite insignificant.

The lunar elliptic tide of the 2nd order ($2N_2$) is ·020 of the Main Tide, which closely approaches the theoretical proportion ·026.

The variational tide (μ_2) is ·037 of the main lunar tide, which is about twice as great a proportion as was found at Pámban, the theoretical value is ·024.

With regard to the diurnal tides, the following shows the comparison between the proportions to the Main Tide as obtained from the 1884-85 observations and the theoretical proportions:—

	1884-85 values.	Theoretical.
Luni-solar (K_1)	0·434	0·584
Lunar Declinational (O_1)	·170	·415
Solar „ (P_1)	·150	·193
„ Elliptic (Q_1)	·053	·080
Lunar Elliptic (J_1)	·056	·033
„ Diurnal (M_1)	·015	·036

With the exception of the lunar elliptic tide (J_1), it will thus be seen that all the diurnal tides are less than they ought to be proportionately to the Main Tide; this is especially the case in the lunar declinational tide, which is only 17 per cent. instead of 42 per cent. There is a great similarity in the diurnal tides at Colombo and Pámban.

The only overtides of importance are the ter-diurnal lunar and the quarter-diurnal lunar, which are each ·027 of the Main Tide, and these proportions agree with what was found at Pámban.

The lunar monthly tide is 0·079 of the Main Tide; this agrees fairly well with the value found at Pámban during the 4 years' observations, but is nearly twice as large as it ought to be theoretically. The epoch of this tide is 18°·4 at Colombo, at Pámban it varied from 349° to 58°.

The lunar fortnightly tide is 6 per cent. of the Main Tide at Colombo; theoretically it should be 9 per cent.; during the 4 years at Pámban it was found to vary from 6 to 10 per cent. The epoch of this tide is 321° at Colombo from the present year's observations; at Pámban it was found to vary from 335° to 2°.

The luni-solar fortnightly tide is ·026 of the Main Tide, which is three times as great as it ought to be: at Pámban it varied from ·012 to ·045 of the Main Tide. The epoch as obtained from the present year's observations is 36°; at Pámban the epoch of this tide was not at all well determined.

The solar annual tide is 60 per cent. of the Main Tide, while at Pámban it was only from 20 to 30 per cent during the 4 years' observations. The epoch of this tide at Colombo is 309°, which would bring the time of maximum about the 26th January; at Pámban its time of maximum varies from the 5th January to 4th February.

The solar semi-annual tide is 23 per cent. of the Main Tide; at Pámban it varied from 23 to 31 per cent., but this tide is obviously meteorological in origin, as the theoretical value is only 4 per cent. Its epoch is 128°, while at Pámban it varied from 96° to 116°. This would give the times of maximum as the 24th May and 24th November, while at Pámban the times of maximum varied from the 8th to the 18th May and from the 8th to the 18th November.

The only compound tide of importance is the quarter-diurnal ($(M_2 N)_4$) which is ·057 of the Main Tide. This tide has been analysed for the first time this year at several stations, and is quite significant in value at most of the ports.

VALUES OF THE TIDAL CONSTANTS, GALLE, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Galle; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations :—

Short Period Tides.

A_o=2·656 feet.

S_1	H = R =	0·011	M_6	R =	0·004	Q_1	R =	0·019	T_2	R =	·
	κ = ζ =	65°·77		ζ =	41°·50		ζ =	169°·36		ζ =	·
S_2	H = R =	0·357		H =	0·004		H =	0·023		H =	·
	κ = ζ =	96°·56		κ =	1°.9		κ =	88°·84		κ =	·
S_4	H = R =	0·002	M_8	R =	0·002	L	R =	0·042	(MS_4)	R =	0·006
	κ = ζ =	205°·20		ζ =	97°·60		ζ =	0°·41		ζ =	85°·91
S_6	H = R =	0·001		H =	0·002		H =	0·036		H =	0·006
	κ = ζ =	564°·29		κ =	284°·91		κ =	67°·31		κ =	312°·74
S_8	H = R =	0·001	O_1	R =	0·036	N	R =	0·055	$(2SM)_2$	R =	0 007
	κ = ζ =	196°·70		ζ =	135°·91		ζ =	203°·80		ζ =	250°·51
				H =	0·044		H =	0·053		H =	0·007
				κ =	78°·75		κ =	47°·26		κ =	23°·69
M_1	R =	0·009	K_1	R =	0·146	λ_2	R =	0·018	$2N_2$	R =	0·007
	ζ =	315°·46		ζ =	97°·31		ζ =	303°·60		ζ =	28°·81
	H =	0·010		H =	0·165		H =	0·018		H =	0·007
	κ =	225°·42		κ =	19°·87		κ =	100°·75		κ =	208°·91
M_2	R =	0·545	K_2	R =	0·070	ν_2	R =	0·050	$(M_2N)_4$	R =	0·028
	ζ =	192°·97		ζ =	67°·34		ζ =	310°·01		ζ =	94°·58
	H =	0·526		H =	0·093		H =	0·048		H =	0·026
	κ =	39°·80		κ =	91°·99		κ =	66°·52		κ =	164°·87
M_3	R =	0·015	P_1	R =	0·053	μ_2	R =	0·027	$(M_2K_1)_3$	R =	0·004
	ζ =	5°·99		ζ =	306°·61		ζ =	8°·16		ζ =	135°·00
	H =	0·014		H =	0·053		H =	0·025		H =	0·005
	κ =	166°·23		κ =	26°·58		κ =	101°·82		κ =	284°·39
M_4	R =	0·010	J_1	R =	0·008	R_2	R =	·	$(2M_2K_2)$	R =	0·002
	ζ =	77·41		ζ =	121°·20		ζ =	·		ζ =	324°·16
	H =	0·009		H =	0·010		H =	·		H =	0·002
	κ =	171°·06		κ =	68°·55		κ =	·		κ =	135°·25

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·075	358°·56	0·067	21°·93
„ Fortnightly Tide	0·013	211 ·06	0·020	12 ·20
Luni-Solar „ „	0·013	191 ·24	0·013	324 ·41
Solar Annual „	0·377	304 ·12	0·377	314 ·15
„ Semi-Annual „	0·097	104 ·69	0·097	124 ·75

The mean level of the sea (A_o) is 2·656 feet above the zero of the gauge.

The mean amplitude (H) of the main lunar tide (M_2) is 0·526 foot; at Colombo it was found to be 0·546. The epoch of this tide at Galle is 59°·8, while at Colombo it is 52°·8, which shows that the tide reaches Colombo about 14 minutes earlier than Galle, neglecting difference of longitude; or, as Galle time is 1½ minutes earlier, this tide reaches Colombo 15½ minutes before reaching Galle according to local time at each place.

The main solar tide (S_2) is 68 per cent. of the main lunar tide; at Colombo it was 66 per cent., and at Pámbsn it varied from 63 to 64 per cent.: thus at Galle the main solar tide has the largest proportion to the main lunar tide yet obtained at any port in India; theoretically it should only be 47 per cent., so at Galle this tide is half as large again as it ought to be. The epoch of the main solar tide at Galle is 96°·6, while at Colombo it is 99°·06, so that this tide reaches Galle 6 minutes earlier than Colombo, neglecting difference of longitude.

As the main solar and main lunar tides combined tend to raise the water very much, more than all the other tides taken together, the time of high-water springs at Colombo would appear to be about 10 minutes (neglecting difference of longitude) earlier than at Galle.

The luni-solar semi-diurnal tide (K_2) is 18 per cent. of the Main Tide; this is too great a proportion, as the theoretical proportion is only 13 per cent.; at Colombo the theoretical proportion was found to obtain. The epoch of this tide at Galle is about 92°, while at Colombo it is about 109°.

With regard to the lunar elliptic tides, the larger component (N_2) is 10 per cent. of the Main Tide, which is only about half as large it ought to be; but at Colombo it was only 12 per cent. The lesser component (L_2) on the other hand has more than twice as great a proportion to the Main Tide as the theoretical proportion, being ·068; at Colombo this tide was also much larger than it ought to be.

The evectional tide (ν_2) is 9 per cent. of the Main Tide; theoretically it should be only 4 per cent. as at Colombo. The lesser evectional tide (λ_2) is ·034 of the Main Tide, theoretically it should be quite insignificant, but at Colombo this tide was even larger, being ·044 of the Main Tide.

The variational tide (μ_2) is ·048 of the Main Tide, which is exactly twice as great as the theoretical proportion: this tide at Colombo is very nearly as great as at Galle.

Thus all the semi-diurnal tides at Galle and Colombo are much greater in amplitude, in comparison to the Main Tide, than the values which theory would assign.

With regard to the diurnal tides, their proportions at Galle and Colombo for the year 1884-85 as well as the theoretical proportions are given below:—

		Galle, 1884-85.	Colombo, 1884-85.	Theoretical.
Luni-solar	(K_1)	0·314	0·434	0·584
Lunar declinational	(O_1)	·084	·170	·415
Solar „	(P_1)	·101	·150	·193
Solar elliptic	(Q_1)	·044	·053	·080
Lunar „	(J_1)	·019	·055	·033
Lunar Diurnal	(M_1)	·019	·015	·036
Solar „	(S_1)	·021	·033	—

Thus it will be seen that all the diurnal tides at Galle and Colombo are very much less than they ought to be by theory; but at Colombo the proportions are generally much greater than they are at Galle.

It may be said that the high values of the semi-diurnal tides and the low values of the diurnal tides form the principal feature of the Galle observations.

The only overtides of importance are the ter-diurnal and the quarter-diurnal lunar, which are ·027 and ·017 respectively of the Main Tide; at Colombo each of those tides was ·027 of the Main Tide.

The lunar monthly tide is 13 per cent. of the Main Tide; at Colombo it was found to be 8 per cent., while the theoretical value is 4½ per cent.

The lunar fortnightly tide is 4 per cent. of the Main Tide; at Colombo it was found to be 6 per cent. while theory gives 9 per cent. as the value.

The luni-solar fortnightly tide is ·025 of the Main Tide, which is precisely the same value as was found at Colombo: its epoch at Galle appears to be about 72° earlier than at Colombo.

The solar annual tide is *72 per cent.* of the Main Tide; at Colombo it was only 60 per cent.; at Pámban this tide was found to vary from 21 to 30 per cent.; but at Negapatam this tide was found to vary from 72 to 76 per cent. If we neglect the high value of this tide at riverain ports, where its amplitude is due to freshets in the river, Galle, Negapatam, and Colombo are the only ports where the solar annual tide has such a high proportion to the main lunar tide, and in fact equals in amplitude the main solar tide (S_2). The epoch of this tide at Galle from the 1884-85 observations is 314°, while at Colombo it was nearly 309°; this would give the times of maximum to be 26th January at Colombo and 1st February at Galle. This tide seems to be meteorological and its time of maximum to be about the middle of the north-east monsoon, or during the time when the so-called "long shore winds" prevail.

The solar semi-annual tide is ·184 of the Main Tide; at Colombo it was found to be larger, being ·225, while at Pámban it varied from ·227 to ·308. The epoch of this tide at Galle appears to be about two days earlier than at Colombo; its times of maximum appear to be about the 22nd May and 22nd November at Galle and the 24th May and 24th November at Colombo: these times fairly correspond to the commencement of the S.-E. and N.-W. monsoons respectively.

VALUES OF THE TIDAL CONSTANTS, VIZAGAPATAM, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Vizagapatam; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short Period Tides.

A_0=4·813 feet.

S_1	H=R=	0·037	M_6	R =	0·004	Q_1	R =	0·017	T_2	R=	.
	κ=ζ=	92°·65		ζ =	117°·22		ζ =	16°·37		ζ=	.
S	H=R=	0·640		H =	0·004		H =	0·020		H=	.
	κ=ζ=	287°·46		κ =	6°·69		κ =	348°·49		κ=	.
S_4	H=R=	0·004	M_8	R =	0·006	L_2	R =	0·044	$(MS)_4$	R=	0·013
	κ=ζ=	66°·62		ζ =	170°·13		ζ =	112°·77		ζ=	287°·07
S_6	H=R=	0·001		H =	0·005		H =	0·046		H=	0·012
	κ=ζ=	146°·31		κ =	214°·77		κ =	280°·56		κ=	28°·23

Short Period Tides—(continued).

A_o=4·813 feet.

S_2	H=R=	0·001	Q_1	R =	0·118	N_2	R =	0·305	$(2SM)_2$	R=	0·005
	κ=ζ=	75°·96		ζ =	102°·92		ζ =	43°·72		ζ=	53°·39
				H =	0·138		H =	0·296		H=	0·004
				κ =	331°·80		κ =	248°·12		κ=	312°·24
M_1	R=	0·010	K_1	R =	0·324	λ_2	R =	0·012	$2N_2$	R =	0·040
	ζ =	11°·20		ζ =	113° 23		ζ =	289°·36		ζ =	296°·44
	H =	0·007		H =	0·355		H =	0·012		H=	0·039
	κ =	351°·40		κ =	342°·32		κ =	213°·56		κ=	244°·06
M_2	R=	1·508	K_2	R =	0·144	ν_2	R =	0·120	$(M_2N)_4$	R=	0·044
	ζ =	153°·59		ζ =	1°·53		ζ =	159° 32		ζ =	84°·57
	H =	1·464		H =	0·181		H =	0·116		H=	0·042
	κ =	254°·75		κ =	278°·86		κ =	257°·14		κ=	30°·12
M_3	R=	0·008	P_1	R =	0·116	μ_2	R =	0·029	$(M_2K_1)_3$	R=	0·021
	ζ =	21°·42		ζ =	203°·41		ζ =	55°·38		ζ =	4°·23
	H =	0·007		H =	0·116		H =	0·028		H=	0·022
	κ =	10°·16		κ =	340°·31		κ =	257°·70		κ=	334°·47
M_4	R=	0·014	J_1	R =	0·022	R_2	R =	.	$(2M_2K_1)_3$	R=	0·010
	ζ =	168°·27		ζ =	218°·83		ζ =	.		=	349°·53
	H =	0·013		H =	0·026		H =	.		H=	0·010
	κ =	10°·58		κ =	342°·87		κ =	.		κ=	322°·76

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·032	8°·05	0·029	264°·82
„ Fortnightly „	0·058	223 ·59	0·082	46 ·98
Luni-Solar „ „	0·026	99 ·48	0·025	·358 ·32
Solar-Annual „	0·612	241 ·44	0·612	194 ·53
„ Semi-annual „	0·364	{220 ·93	0·364	127 ·12

The value of (A_o) Mean Level of the Sea is 4·813 feet above the zero of the gauge which is the same as was found in the last year, and practically the same as the 1881-82 value. The values obtained for the two years 1879-80 and 1880-81 were about 0·2 foot and 0·1 foot respectively higher than the values for each of the 3 last years.

The mean amplitude (H) of the main lunar tide (M_2) is 1·464 feet, which is slightly greater than what was obtained in the two previous years, but is almost the same value as in 1880-81. The value however in 1879-80 was considerably greater than that now found, being 1·532. The epoch (κ) for this year is practically the same as that found in the last 3 years' reductions: for 1879-80 the value obtained is somewhat outstanding, being 5½° different, which represents a discrepancy of 11 minutes in time.

With regard to the Main Solar Tide (S_2), its amplitude is 0·640 foot, which agrees with the 1882-83 value, and is very much the same as was found in the two former years. The amplitude obtained in 1879-80 is, as was the case in the main lunar tide, somewhat greater than any of the subsequent values. The epoch is fairly accordant in all the last 4 years: while in 1879-80 there is a difference of about 6° or 12 minutes in time from the mean of the last 4 years.

The proportion of the main solar to the main lunar tide is 0·437; theoretically it should be 0·465; in former years the general proportion has been found to be about 0·445.

The lunar elliptic semi-diurnal tides (N_2) and (L_2) are respectively 20 and 3 per cent. of the Main Tide, which are almost identical with the theoretical proportions (19 and 3 per cent.) The epoch of the principal of these tides, (N_2), is fairly consistent year by year at Vizagapatam, the greatest discrepancy between any two years being about 10°, but the epoch of the lesser constituent (L_2) is not consistent.

Regarding the evectional tides, the larger component (ν_2) is again about twice as large as it ought to be, in proportion to the Main Tide, *viz.*, ·079; theoretically it should be ·037. The same thing was noticed last year, while in 1881-82 it was absolutely *nil* in comparison to the Main Tide, and again in the previous year, 1880-81, the proportion was practically the same as the theoretical value; but in 1879-80, it has doubled its proper value. The epoch of this tide at Vizagapatam shows great fluctuation in the values obtained. The lesser evectional tide is, as it should be, about 1 per cent. of the Main Tide, and this has always been found to obtain at Vizagapatam; its epoch however is very variable.

The luni-solar semi-diurnal tide (K_2) is a little more than 12 per cent. of the Main Tide, which is the theoretical value. Last year the value obtained was too great, being 21 per cent. of M_2, but in the 3 years before that the proportion agreed very well with theory. The epoch of this tide as obtained from the 1883-84 observations is the same as was found last year, and it may be said that the values obtained for the epoch for all five years at Vizagapatam are not very divergent.

The Variational Tide (μ_2) is 2 per cent. of the Main Tide, as has usually been found at Vizagapatam, and this agrees with theory.

With regard to the diurnal tides they are all much smaller in portion to the Main Tide than the theoretical values, and this has always been found to exist at Vizagapatam: but the proportions this year agree well with what was found in former years.

The following shows the proportions to the Main Tide obtained at Vizagapatam for 1883-84, as compared to the values theory would assign:—

		1883-84.	Theoretical.
Luni-solar	(K_1)	0·242	0·534
Lunar	(M_1)	·005	·036
Solar declinational	(P_1)	·079	·193
Lunar declinational	(O_1)	·094	·415
Lunar elliptic	(J_1)	·018	·033
Solar ,,	(Q_1)	·014	·080

With the exception of M_1, J_1, and Q_1, the epochs (κ) of the other diurnal tides agree well year by year, and their values may be considered fairly well determined; but for the three tides named the epochs are not consistent year by year.

As has always been found the case at Vizagapatam, the whole of the overtides are quite insignificant, the largest being the lunar quarter-diurnal, which is only 1 per cent. of the Main Tide, and thus agrees with former values.

Turning now to the long-period tides. The lunar monthly (*Mm*) is 2 per cent. of the Main Tide; this tide seems to be alternately 2 and 5 per cent. of the Main Tide year by year; theoretically it should be 4½ per cent. The epoch of this tide is very variable, and cannot be considered well determined at Vizagapatam.

The lunar fortnightly tide is ·056 of the Main Tide at Vizagapatam; theoretically it should be ·086, but at this port the tide has been always found too small and varying from ·019 to ·042 of M_2. Its epoch, although not so variable as that of the lunar monthly, cannot be considered well defined, as there is a difference of 60° (or over two days) in the time of maximum between the greatest and least values.

Regarding the luni-solar fortnightly tide, it is about 3 times greater than the theoretical value in proportion to the Main Tide, being ·017 against ·007; this tide seems to vary at Vizagapatam from ·014 to ·050 of the main lunar tide. The values of the epoch of this tide are most irregular.

With regard to the solar-annual tide, it is 42 per cent. of the Main Tide: in former years this tide has varied in its proportion to the Main Tide from 40 to 57 per cent.

The semi-annual tide is this year 25 per cent. of the Main Tide, and this tide at Vizagapatam has been found to vary from 17 to 31 per cent. of the Main Tide.

It is worth noticing that, while the solar annual tide is less this year than it was last year, the semi-annual tide is greater this year than it was last year. The very large values of these two long-period tides however is the peculiar feature of the Vizagapatam tides, and undoubtedly they are meteorological in origin. The epochs of the solar annual tide and also of the semi-annual tide are later than they were found last year by about 20 days.

VALUES OF THE TIDAL CONSTANTS, FALSE POINT, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at False Point, and also the mean vales of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short Period Tides.

A_0=7·593 feet.

S_1	H=R=	0·006	M_6	R=	0·015	Q_1	R=	0·010	T_2	R=	.
	κ=ζ=	47°·55		ζ=	343°·66		ζ=	82°·26		ζ=	.
S_2	H=R=	0·993		H=	0·014		H=	0·012		H=	.
	κ=ζ=	302°·09		κ=	43°·84		κ=	311°·94		κ=	.
S_4	H=R=	0·009	M_8	R=	0·007	L_2	R=	0·069	$(MS)_4$	R=	0·042
	κ=ζ=	315°·96		ζ=	351°·72		ζ=	2°·26		ζ=	126°·22
S_6	H=R=	0·003		H=	0·006		H=	0·068		H=	0·041
	κ=ζ=	163°·30		κ=	191°·97		κ=	265°·77		κ=	266°·28
S_8	H=R=	0·004	O_1	R=	0·149	N_2	R=	0·438	$(2SM)_2$	R=	0·021
	κ=ζ=	280°·54		ζ=	151°·27		ζ=	76°·87		ζ=	329°·28
				H=	0·176		H=	0·425		H=	0·020
				κ=	334°·24		κ=	263°·65		κ=	189°·22
M_1	R=	0·019	K_1	R=	0·373	λ_2	R=	0·020	$2N_2$	R=	0·068
	ζ=	280°·53		ζ=	29°·57		ζ=	102°·69		ζ=	4°·83
	H=	0·014		H=	0·413		H=	0·019		H=	0·066
	κ=	286°·59		κ=	343°·77		κ=	330°·52		κ=	238°·31
M_2	R=	2·340	K_2	R=	0·226	ν_2	R=	0·037	$(M_2N)_4$	R=	0·018
	ζ=	129°·34		ζ=	219°·67		ζ=	72°·21		ζ=	33°·04
	H=	2·267		H=	0·289		H=	0·036		H=	0·017
	κ=	269°·40		κ=	307°·24		κ=	304°·50		κ=	359°·87
M_3	R=	0·013	P_1	R=	0·127	μ_2	R=	0·074	$(M_1K_1)_3$	R=	0·025
	ζ=	185°·89		ζ=	294°·45		ζ=	345°·09		ζ=	6°·68
	H=	0·012		H=	0·127		H=	0·069		H=	0·027
	κ=	35°·98		κ=	345°·62		κ=	265°·21		κ=	100°·95
M_4	R=	0·037	J_1	R=	0·027	R_2	R=	..	$(2M_1K_1)_3$	R=	0·010
	ζ=	303°·78		ζ=	58°·82		ζ=	.		ζ=	19°·98
	H=	0·035		H=	0·031		H=	.		H=	0·010
	κ=	223°·90		κ=	329°·20		κ=	.		κ=	345°·91

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·050	161°·24	0·045	114°·53
„ Fortnightly „	0·046	58 ·51	0·067	12 ·63
Luni-Solar „ „	0·040	297 ·83	0·039	157 ·77
Solar-Annual „	0·841	133 ·45	0·841	172 ·28
„ Semi-Annual	2·282	75 ·92	0·282	153 ·59

The value of the mean level of the sea (A_0) is 7·593 feet above the zero of the gauge which is almost precisely the same as last year's value, while in 1881-82 it was 0·04 of a foot lower.

The mean amplitude (H) of the main lunar tide is 2·267 feet, which is the highest value yet obtained at False Point, but it only differs by two-hundredths of a foot from the lowest value during the 3 years' observations. The epoch of this tide is well determined at False Point, the greatest discrepancy during the 3 years being 2°·3, that is under 5 minutes in time.

The proportion of the main solar tide to the main lunar tide is 0·438; in the two former years the proportion was slightly higher, but the mean proportion from the 3 years' observations is very close to the theoretical proportion 0·465. The epoch of this tide also is well determined at False Point, the greatest discrepancy in the 3 values deduced being 2°·7, or a little over 5 minutes in time.

With regard to the lunar elliptic tides, the principal component (N_2) is 0·187 of the Main Tide, which almost agrees with the theoretical proportion 0·194; the proportions in the two former years were slightly too high, nevertheless the mean of the 3 years' observations would coincide with the theoretical proportion. The epoch of this tide also at False Point is well determined.

The smaller component (L_2) is 3 per cent. of the Main Tide, which is the theoretical proportion; the same thing was found in the values obtained for the two former years. There is a considerable discrepancy in the values obtained for the epoch of this tide.

Regarding the evectional tides (ν_2) and (λ_2) the former is 0·016 of the Main Tide, which is about half as large as it ought to be, while in the two former years the proportions obtained exceeded the theoretical value; but the smaller component (λ_2) is this year quite insignificant, as it ought to be by theory, while in the two former years the proportions to the Main Tide were considerably in excess of what they should be. The epochs of these two tides, however, have not been well determined at False Point.

The luni-solar semi-diurnal tide (K_2) is 13 per cent. of the Main Tide, which is the theoretical proportion; last year the proportion was 11 per cent. and in 1881-82 it was 12 per cent. of the Main Tide. The values of the epoch of this tide for the first two years of observation agree very closely, but the value obtained this year is somewhat outstanding and differs from the two former values by 10½°.

The lunar elliptic tide of the 2nd order ($2N_2$) has been analysed for the first time this year, and its proportion to the Main Tide agrees very closely with the theoretical value.

With regard to the diurnal tides, they are all very much smaller than they ought to be according to theory; nevertheless they are all very accordant with the values obtained in the two former years. Their proportions to the Main Tide as obtained from this year's observations compared with the theoretical proportions are as follow:—

		Value for 1883-84.	Theoretical.
Luni-solar Diurnal	(K_1)	0·182	0·584
Lunar Declinational	(O_1)	·078	·415
Solar „	(P_1)	·056	·193
„ Elliptic	(Q_1)	·005	·080
Lunar „	(J_1)	·014	·033
„ Diurnal	(M_1)	·006	·036

The epochs of the following diurnal tides are well determined at False Point, *viz.*, the luni-solar diurnal (K_1), the solar declinational (O_1), and the lunar declinational (P_1); these are the principal diurnal co-efficients but the epochs of J_1 and Q_1 do not vary more than is usually found at other stations.

The only overtide of any importance is the lunar quarter-diurnal (M_4) which is 2 per cent. of the Main Tide, and agrees with the two former values: its epoch has been fairly well determined, the greatest discrepancy being 12° or about 12 minutes in time.

With regard to the long-period tides, the lunar monthly, the lunar fortnightly, and the luni-solar fortnightly, all agree very fairly well in their proportions to the Main Tide; with the values found in the two previous years, their proportions are this year 2, 3, and 2 per cent. of the Main Tide.

The solar annual tide is 0·371 of the Main Tide, which may be said to be exactly the same as the proportion found last year, and does not materially differ from the 1881-82 value. The time of maximum of this tide seems to be very well determined at False Point, as the epochs for all 3 years agree very well together, the greatest discrepancy being 6½°. The time of maximum would appear to be about 7th September.

The solar semi-annual tide is this year 12 per cent. of the Main Tide; last year it was 9 per cent., and in 1881-82 it was 16 per cent.; its epoch also appears to be very well determined, the greatest discrepancy between any two of the 3 values being 11°, which represents a difference of 5½ days in time. The times of maximum of this tide would appear to be be about the 2nd June and 2nd September.

VALUES OF THE TIDAL CONSTANTS, DUBLAT, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Dublat; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short Period Tides.

A_0=14·417 feet.

S_1	H=R=	0·040	M_6	R =	0·009	Q_1	R =	0·011	T_2	R=	.
	$\kappa=\zeta=$	142°·28		ζ =	250°·88		ζ =	155°·34		ζ =	.
S_2	H=R=	2·147		H =	0·008		H =	0·013		H =	.
	$\kappa=\zeta=$	328°·84		κ =	249°·69		κ =	10°·96		κ =	.
S_4	H=R=	0·017	M_8	R =	0·014	L_2	R =	0·215	$(MS)_4$	R=	0·069
	$\kappa=\zeta=$	201°·23		ζ =	280°·81		ζ =	289°·74		ζ =	174°·23
S_6	H=R=	0·005		H =	0·012		H =	0·210		H =	0·067
	$\kappa=\zeta=$	40°·24		κ =	279°·22		κ =	295°·09		κ =	173°·83
S_8	H=R=	0·003	O_1	R =	0·157	N_2	R =	0·846	$(2SM)_2$	R=	0·055
	$\kappa=\zeta=$	88°·26		ζ =	290°·95		ζ =	121°·12		ζ =	192°·60
				H =	0·186		H =	0·820		H =	0·053
				κ =	342°·23		κ =	285°·06		κ =	193°·00
M_1	R =	0·023	K_1	R =	0·456	λ_2	R =	0·087	$2N_2$	R=	0·099
	ζ =	307°·32		ζ =	46°·22		ζ =	275°·72		ζ =	253°·15
	H =	0·017		H =	0·503		H =	0·085		H =	0·096
	κ =	62°·44		κ =	351°·62		κ =	261°·20		κ =	221°·44
M_2	R =	4·741	K_2	R =	0·470	ν_2	R =	0·146	$(MN)_4$	R=	0·183
	ζ =	290°·89		ζ =	258°·42		ζ =	101°·19		ζ =	251°·68
	H =	4·594		H =	0·599		H =	0·142		H =	0·172
	κ =	290°·49		κ =	328°·38		κ =	294°·91		κ =	55°·23
M_3	R =	0·053	P_1	R =	0 141	μ_2	R =	0·184	$(M_2K_1)_3$	R=	0·021
	ζ =	318°·62		ζ =	287°·37		ζ =	14°·91		H =	48°·34
	H =	0·051		H =	0·141		H =	0·172		ζ =	0·023
	κ =	138°·02		κ =	347°·41		κ =	14°·11		κ =	353°·34
M_4	R =	0·086	J_1	R =	0·019	R_2	R =	.	$(2M_2K_2)_3$	R=	0·027
	ζ =	149°·62		ζ =	163°·36		ζ =	.		ζ =	71°·29
	H =	0·081		H =	0·022		H =	.		H =	0·028
	κ =	148 ·83		κ =	307°·33		κ =	.		κ =	125°·09

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·067	239°·73	0·060	75°·39
„ Fortnightly „	0·064	328 ·90	0·092	45 ·93
Luni-Solar „ „	0.052	127 ·76	0·050	128 ·16
Solar-Annual „	0·864	122 ·95	0·864	152 ·91
„ Semi-Annual „	0·202	73 ·68	0·202	133 ·60

The value of A_0, the mean level of the sea, is 14·417 feet above the zero of the gauge, which agrees pretty closely with the 1881-82 values, but is about an inch lower than the value obtained in 1882-83.

The mean amplitude (H) of the main lunar tide is 4·594, which is precisely the value obtained last year, and only differs from the 1881-82 value by ·03 foot or about a third of an inch. The epoch of this tide is very closely determined at Dublat, the greatest discrepancy between any 2 of the 3 values being 0°·82 or about 1½ minutes in time.

The proportion of the main solar to the main lunar tide is ·467; this may be said to be precisely the theoretical value; last year the proportion was a little too high, and in 1881-82 the proportion was somewhat too small; but the mean of all 3 years agrees with the theoretical proportion to the Main Tide. The epoch of this tide is also very well determined, the greatest discrepancy between any 2 values of the 3 years being 2½° or about 5 minutes in time.

With regard to the lunar elliptic tides the principal component (N_2) is 18 per cent. of the Main Tide; theoretically it should be 19 per cent. as was obtained last year. The smaller

component (L_2) is this year about twice as large as it ought to be, but the proportions obtained in the two former years were also somewhat greater than the theoretical value. The epochs of both these tides are well determined at Dublat.

Regarding the evectional tides, the larger component (ν_2) is ·031 of the Main Tide, which is slightly less than the theoretical proportion, while in the two former years it was slightly too great; the smaller component (λ_2) is ·019 of the Main Tide; theoretically this tide should be perfectly insignificant, but the proportions obtained in the two previous years were still higher, being ·030 and ·064 of the Main Tide. The epochs, however, of these tides have not been well determined at Dublat.

The luni-solar semi-diurnal tide (K_2) is 13 per cent. of the Main Tide, which is the theoretical proportion, and this proportion was found to obtain in the two previous years. The epoch, however, of this tide varies considerably at Dublat.

The lunar elliptic tide of the 2nd order ($2N_2$) has this year been analysed for the first time; its proportion to the Main Tide is ·021; theoretically it should be ·026.

The diurnal tides at Dublat are all very small in comparison to the Main Tide. The proportions to the Main Tide of the 3 significant diurnal tides are as follows: the luni-solar (K_1) 11 per cent., the lunar declinational (O_1) 4 per cent., and the solar declinational (P_1) 3 per cent.; these proportions are very accordant with the two previous values, but vary considerably from the theoretical proportions, which are respectively 58, 42, and 19 per cent. of the main lunar tide. The epochs of the three significant diurnal tides have all been well determined at Dublat, the values obtained in all three years being very accordant.

The only overtides of importance are the ter-diurnal lunar, and the quarter-diurnal lunar, which are respectively ·011 and ·018 of the Main Tide; these values are in accordance with what was obtained in the two previous years. The epochs of these overtides have been very well determined at Dublat.

With regard to the long-period tides, the lunar monthly is ·013 of the Main Tide, which is nearly the same proportion as was found in the two previous years, but differs considerably from the theoretical proportion ·046; the epoch of this tide is not well determined.

The lunar fortnightly is ·020 of the Main Tide, which is not very different from the two former values, but theory gives ·086 as the proper proportion. The epoch of this tide varies by 25° in the values obtained for the three years' observations which have been reduced.

The luni-solar fortnightly is ·011 of the Main Tide, which agrees fairly well with the two former values. The epoch of this tide has not been well determined at Dublat, whereas at Diamond Harbour and Kidderpore it has been closely determined.

The solar annual tide is ·188 of the main lunar tide, a proportion which is very nearly a mean between the two previous years' values; the epoch of this tide only differs by 7° between the lowest and greatest values of the three years' values which have been analysed, and its time of maximum appears to be at Dublat about the 21st August.

The solar semi-annual tide is ·044 of the Main Tide which agrees well with the two former values; its epoch appears to vary considerably, there being a difference of 52° between the greatest and least values. The times of maximum of this tide appear to be about the 5th August and 5th February.

VALUES OF THE TIDAL CONSTANTS, DIAMOND HARBOUR, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Diamond Harbour; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short Period Tides.

A_0 = 8·999 feet.

S_1	H = R = 0·093; $\kappa = \zeta =$ 149°·53	M_6	R = 0·179; ζ = 230°·42; H = 0·163; κ = 105°·93	Q_1	R = 0·031; ζ = 117°·07; H = 0·036; κ = 304°·32	T_2	R = ·; ζ = ·; H = ·; κ = ·
S_2	H = R = 2·252; $\kappa = \zeta =$ 26°·15	M_8	R = 0·068; ζ = 29°·90; H = 0·060; κ = 343°·91	L_{2_2}	R = 0·203; ζ = 126°·33; H = 0·261; κ = 335°·29	$(MS)_4$	R = 0·724; ζ = 209°·02; H = 0·702; κ = 287°·52
S_3	H = R = 0·132; $\kappa = \zeta =$ 330°·30	O_1	R = 0·179; ζ = 194°·39; H = 0·211; κ = 342°·12	N_2	R = 0·927; ζ = 217°·78; H = 0·898; κ = 335°·80	$(2SM)_2$	R = 0·059; ζ = 352°·27; H = 0·058; κ = 273°·77
S_6	H = R = 0·015; $\kappa = \zeta =$ 267°·73	K_1	R = 0·461; ζ = 87°·72; H = 0·508; κ = 15°·50	λ_2	R = 0·048; ζ = 161°·80; H = 0·046; κ = 22°·48	$2N_2$	R = 0·218; ζ = 129°·97; H = 0·212; κ = 287°·50
S_8	H = R = 0·004; $\kappa = \zeta =$ 240°·64						
M_1	R = 0·051; ζ = 171°·87; H = 0·022; κ = 145°·06						

Short Period Tides—(continued).

$A_0 = 8{\cdot}999$ feet.

M_2	R =	5·340	K_2	R =	0·575	ν_2	R =	0·210	$(M_2N)_4$	R =	0·107
	ζ =	265°·80		ζ =	349°·92		ζ =	229°·80		ζ =	234°·48
	H =	5·177		H =	0·730		H =	0·204		H =	0·100
	κ =	344°·30		κ =	24°·65		κ =	346°·13		κ =	71°·01
M_3	R =	0·064	P_1	R =	0·173	μ_2	R =	0·317	$(M_2K_1)_3$	R =	0·116
	ζ =	126°·93		ζ =	290°·83		ζ =	293°·04		ζ =	242°·76
	H =	0·061		H =	0·173		H =	0·298		H =	0·124
	κ =	244°·68		κ =	8°·61		κ =	90°·05		κ =	249°·04
M_4	R =	0·800	J_1	R =	0·005	R_2	R =	·	$(2M_2K_1)_3$	R =	0·064
	ζ =	89°·26		ζ =	176°·70		ζ =	·		ζ =	344°·80
	H =	0·752		H =	0·006		H =	·		H =	0·066
	κ =	246°·27		κ =	67°·95		κ =	·		κ =	214° 03

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·173	65°·24	0·156	25°·72
„ Fortnightly „	0·150	94 ·17	0·216	57 ·21
Luni-Solar „ „	0·467	119 ·11	0·453	40 ·61
Solar-Annual „	0·980	128 ·59	0·980	140 ·81
„ Semi-Annual „	0·103	67 ·38	0·103	91 ·82

The mean level of the water at Diamond Harbour for 1883-84 is not materially different from the value obtained last year, and is a fair mean between the 1881-82 and 1882-83 values.

The *mean* amplitude of the main lunar tide (H of M_2) is 5·177 feet, and this is almost precisely the same as the two former values; whereas the discrepancies in the R's for the 3 years for this tide are over one-tenth of a foot.

The value of the main solar tide (H of S_2) is 2·252, which is very nearly a mean between the two former values, which differed from each other by less than an inch.

The epoch of the main lunar tide is very close to that obtained for the 2 previous years, the greatest difference between any 2 of the 3 values being 1°·2 or about 2 minutes in time. The epoch of the main solar tide also agrees this year very well as compared with the two previous values, and here the greatest discrepancy in any 2 of the 3 years is less than 1° or under two minutes in time.

The proportion of the main solar tide to the main lunar tide is 0·435, which is not very different from the theoretical value 0·465.

The luni-solar semi-diurnal tide (K_2) is 0·141 of the Main Tide: theoretically it should be 0·127, and for the two previous years the theoretical proportion was very nearly obtained; this year this tidal constituent is larger than usual.

The larger lunar elliptic tide (N_2) should be 0·194 of the Main Tide; for 1881-82 the value was very nearly the theoretical, but for 1882-83 and for the present year the values of this tide have been too small, *viz.*, 0·176 and 0·173 respectively.

The smaller elliptic lunar tide is for this year 0·039 of the Main Tide; theoretically it should be 0·028; in 1881-82 this proportion was very nearly obtained, but in 1882-83 it was too large, *viz.*, 0·067.

The larger evectional tide (ν_2) agrees this year, in its proportion to the Main Tide, with the theoretical value; last year this also was the case, but in 1881-82 the tide was too great.

The smaller evectional tide also agrees with the theoretical value this year in being insignificant, and this tide in 1881-82 was too large.

The lunar elliptic tide of the 2nd order ($2N_2$), which has been calculated for the first time this year, is 0·041 of the Main Tide which is too large, theoretically its proper proportion being 0·026.

The variational tide (μ_2) agrees, in its proportion to the Main Tide, with former values, and is too great theoretically at Diamond Harbour; this tide appears to be ·059 of the Main Tide, whereas it should only be 0·024.

Regarding the diurnal tides, they are as usual all very small in proportion to the Main Tide compared to the theoretical proportions, but this has always been found to be the case at Diamond Harbour as well as at the other stations in the Hooghly. The following table shows the proportion to the Main Tide and the theoretical proportions :—

	Proportion to M_2 in 1883-84.	Theoretical proportion to M_2.
Luni-Solar Diurnal (K_1)	·098	0·584
Lunar Declinational (O_1)	·041	·415
Solar „ (P_1)	·033	·193
„ Elliptic (Q_1)	·007	·080
Lunar „ (J_1)	·001	·033
Lunar Diurnal (M_1)	·004	·036
Solar „ (S_1)	·018	No theoretical comparison.

Thus it will be seen that all the diurnal tides are quite insignificant at Diamond Harbour compared to what they ought to be. But the values this year are quite in accordance with what has been obtained in the 2 previous years.

In fact the agreement of the values of the diurnal tides *inter se* as regards their amplitudes is extremely close for the 3 years, except the lunar elliptic (J_1), which this year is 0·006 of a foot against 0·030 and 0·029 of the 2 previous years which agreed with the theoretical proportion. But as regards the epoch of the diurnal tides, the values of κ for J_1, Q_1 and M_1 are not very accordant with what was found to obtain in the 2 previous years, whereas the values for the other diurnal tides agree very fairly well.

For M_1 the value of κ is 145° for this year, whereas in 1881-82 the value was 88°; for J_1 the value of κ for 1883-84 is 68°, and in 1881-82 it was 299°; for Q_1 the value of κ this year is 304°, and in 1881-82 it was 9°.

Regarding the overtides the greatest is of course the lunar quarter-diurnal, which is 0·145 of the Main Tide, and agrees well with what was obtained for former years; its epoch too is very accordant with the values of the 2 previous years, the greatest discrepancy in any 2 of the 3 years being only about 1°.

The ter-diurnal lunar (H of M_3) appears to be about 1 per cent. of the Main Tide.

The sexter-diurnal (H of M_6) is 3 per cent of the Main Tide, and the values for all 3 years. are very accordant both as regards amplitude and epoch.

The octo-diurnal (H of M_8) is a little more than one per cent. of the Main Tide, and it also agrees well both as regards amplitude and epoch with what was obtained in former years.

All the solar overtides agree in their values this year with what was seen formerly, but the only significant one is the quarter-diurnal (S_4) which is ·025 of the Main Tide.

Regarding the compound tides, three new ones have been evaluated this year, *viz.*, M_2K_1, $2M_2K_1$, and M_2N. But the only significant compound tide at Diamond Harbour is the quarter-diurnal $(MS)_4$, which is ·136 of the Main Tide, a value strictly in accordance with the former values: its epoch too is in agreement with that found formerly at Diamond Harbour.

Regarding the long-period tides, the lunar monthly has an amplitude of 0·16 foot, and thus agrees with the 1881-82 value, while in 1882-83, it was only 0·06 foot.

The lunar fortnightly tide is for this year 0·22 foot in amplitude; in the 2 previous years it was only 0·14 and 0·16. The values of the epochs are fairly consistent in all 3 years, the greatest variation being 19° between any 2 of the 3 years' values.

The luni-solar fortnightly tide is a tide of considerable importance at Diamond Harbour, its amplitude this year being half a foot very nearly, which is much the same as in the 2 previous years: its epoch (κ) too seems well established, varying from 26° to 40°.

Regarding the solar annual tide, the amplitude this year is the least yet obtained, being slightly under a foot (0·979), whereas last year it was over 1 foot 2 inches (1·189), but in 1881-82 it was only slightly over a foot. The epoch this year is almost precisely the same as in 1881-82, and only differs from that obtained last year by 6°. The time of maximum would appear to be well established as about 11th August.

The solar semi-annual tide has an amplitude 0·102, and this agrees with last year's value: the 1881-82 value is outstanding, being only 0·023: the epochs are not consistent, varying from 64° to 91°, but this has also been found the case at Kidderpore and Dublat.

VALUES OF THE TIDAL CONSTANTS, KIDDERPORE, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Kidderpore; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short Period Tides.

$A_0 = 10{\cdot}599$ feet.

S_1	H = R =	0·097	M_6	R =	0·172	Q_1	R =	0·036	T_2	R =	.
	$\kappa = \zeta$ =	193°·42		ζ =	203°·91		ζ =	23°·10		ζ =	.
S_2	H = R =	1·513		H =	0·156		H =	0·036		H =	.
	$\kappa = \zeta$ =	102°·95		κ =	310°·40		κ =	349°·87		κ =	.
S_4	H = R =	0·095	M_8	R =	0·083	L_2	R =	0·222	$(MS)_4$	R =	0·665
	$\kappa = \zeta$ =	124°·12		ζ =	125°·60		ζ =	63°·16		ζ =	46°·96
S_6	H = R =	0·003		H =	0·073		H =	0·222		H =	0·645
	$\kappa = \zeta$ =	58°·67		κ =	267°·59		κ =	59°·20		κ =	82°·46
S_8	H = R =	0·002	O_1	R =	0·175	N_2	R =	0·648	$(2SM)_2$	R =	0·065
	$\kappa = \zeta$ =	227°·29		ζ =	258°·18		ζ =	157°·16		ζ =	50°·25
				H =	0·206		H =	0·628		H =	0·063
				κ =	15°·58		κ =	42°·03		κ =	14°·75
M_1	R =	0·048	K_1	R =	0·363	λ_2	R =	0·093	$2N_2$	R =	0·128
	ζ =	47°·10		ζ =	140°·25		ζ =	12°·98		ζ =	260°·64
	H =	0·034		H =	0·400		H =	0·091		H =	0·124
	κ =	177°·81		κ =	55°·31		κ =	43°·54		κ =	354°·88

Short Period Tides—(continued).

A_0=10·599 feet.

M_2	R =	3·760	K_2	R =	0·398	ν_2	R =	0·175	$(M_2N)_4$	R =	0·115
	=	22°·39		ζ =	93°·85		ζ =	201°·09		ζ =	13°·03
	H =	3·646		H =	0·504		H =	0·170		H =	0·108
	κ =	57°·88		κ =	108°·14		κ =	61°·53		κ =	293°·39
M_3	R =	0·029	P_1	R =	0·140	μ_2	R =	0·313	$(M_2K_1)_3$	R =	0·135
	ζ =	117°·02		ζ =	318°·49		ζ =	109°·72		ζ =	88°·30
	H =	0·028		H =	0·140		H =	0·294		H =	0·144
	κ =	350°·26		κ =	49°·09		κ =	180°·71		κ =	38°·86
M_4	R =	0·735	J_1	R =	0·014	R_2	R =	.	$(2M_2K_2)_4$	R =	0 031
	ζ =	325°·03		ζ =	248°·27		ζ =	.		ζ =	140°·17
	H =	0·691		H =	0·017		H =	.		H =	0·032
	κ =	36°·03		κ =	317°·00		κ =	.		κ =	296°·10

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·322	231°·26	0·290	21°·89
„ Fortnightly „	0.242	72 ·88	0·346	53 ·58
Luni-Solar „ „	0·933	82 ·14	0·905	46 ·64
Solar-Annual „	2·312	150 ·39	2·312	149 ·80
„ Semi-Annual „	0·714	322 ·77	0·714	321 ·58

The main lunar tide is 3·646 feet in amplitude, which is almost precisely the same as the value obtained in the 2 former years. The epoch is very consistent with the values obtained in 1881-82 and 1882-83.

The main solar tide has an amplitude 1½ feet almost exactly, and thus agrees with the 1882-83 value; in 1881-82 the value obtained was somewhat less. The epoch differs by 2°·5 (5 minutes in time) from the value in 1882-83, and by 1° (2 minutes in time) from the 1881-82 value. The proportion of the main solar to the main lunar tide is ·415, which is the nearest of all the 3 years to the theoretical value, *viz.*, ·465.

The luni-solar semi-diurnal tide is 14 per cent. of the Main Tide, which is very slightly greater than the theoretical proportion; last year it was slightly in defect, while for 1881-82 it agreed with the theoretical proportion.

The lunar elliptic tide (N_2) is 17 per cent. of the Main Tide, which is accordant with the two former values, and agrees very well with the theoretical proportion, *viz.*, 19 per cent.

The smaller lunar elliptic tide (L_2) is 6 per cent. of the Main Tide, which is about double what it ought to be; but the same thing was noticed in the two former years.

The evectional tides (ν_2 and λ_2) are respectively 5 and 3 per cent. of the Main Tide; theoretically ν_2 should be 4 per cent., while λ_2 should be barely 1 per cent.

The variational (μ_2) is 8 per cent. of the Main Tide, which is about 3 times too great; but in 1881-82 and in 1882-83 it was 6 and 7 per cent. of the Main Tide respectively.

With regard to the diurnal tides, they all agree very closely in their proportion to the Main Tide with the values obtained in the two former years, and they are all very much smaller in proportion than they ought to be according to theory; but the diurnal components in the Hooghly are all very small.

With regard to the overtides, the most important is the lunar quarter-diurnal, which is 19 per cent. of the Main Tide and agrees very well with the former values. The other lunar overtides, M_6 and M_8, are 2 and 3 per cent. of the Main Tide, values which are in accordance with those formerly obtained.

The solar quarter-diurnal is 3 per cent. of the Main Tide, and therefore agrees fairly well with the values found in the 2 previous years. The other solar overtides are as usual perfectly insignificant.

The lunar monthly tide is 8 per cent. of the Main Tide; last year it agreed with the theoretical proportion, *viz.*, 5 per cent., while in 1881-82 it was 9 per cent.

The lunar fortnightly tide is somewhat larger this year, being 10 per cent. of the Main Tide, while in each of the 2 former years it was 8 per cent., the theoretical value being 9 per cent.

The luni-solar fortnightly tide is again 25 per cent. of the Main Tide, and agrees with the former values.

The solar annual tide is 63 per cent of the Main Tide, which is 10 per cent. less than the values in the 2 former years.

The solar semi-annual tide is 20 per cent. of the Main Tide, in 1881-82 it was 26 per cent., while in 1882-83 it was 19 per cent.

The most important compound tide is the quarter-diurnal (MS_4), which is 18 per cent. of the Main Tide, and agrees precisely with the 2 former values.

With regard to the epochs, the diurnal tides O_1, K_1 and P_1, agree very fairly well with former values. The epoch of J_1 is not accordant with either of the two former values, and the same may be said of the epoch of Q_1.

The epoch of the luni-solar semi-diurnal tide is 103°, which agrees well with last year's value, but is 18° different from the value obtained in 1881-82.

The epoch of the lunar elliptic tide L_2 agrees well with last year's value, but is 26° different from that in 1881-82.

The epoch however of the larger lunar elliptic tide N_2 is very accordant in all 3 years of the observations.

The epoch of the principal overtide M_4 agrees well with the 2 former years' values, and the same may be said of the epoch of the compound tide MS_4.

The epoch of the lunar monthly tide differs by 40° from the 1882-83 value, and by 2 0 from the 1881-82 value.

The lunar fortnightly tide is also discordant in the values of its epoch.

With regard to the epoch of the luni-solar fortnightly tide, the greatest discrepancy between any 2 years is only 12°, so that this tide at Kidderpore seems to be well established.

The solar annual tide has its maximum about 7 days earlier than in the 2 previous years, while the solar semi-annual has its maximum about the same number of days before the value obtained in 1882-83. The epoch of the solar semi-annual tide in 1881-82 was altogether different from the values found in the two former years.

VALUES OF THE TIDAL CONSTANTS, RANGOON, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Rangoon; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short Period Tides.

A_0=14·925 feet.

S_1	H=R=	0·118	M_6	R=	0·250	Q_1	R=	0·038	T_2	R=	0·222
	κ=ζ=	129°·60		ζ=	243°·05		ζ=	13°·27		ζ=	240°·61
S_2	H=R=	1·995		H=	0·228		H=	0·045		H=	0·222
	κ=ζ=	170°·17		κ=	87°·27		κ=	67°·76		κ=	182°·87
S_4	H=R=	0·083	M_8	R=	0·106	L_2	R=	0·420	$M)_4$	R=	0·434
	κ=ζ=	257°·46		ζ=	62°·79		ζ=	268°·58		ζ=	248°·89
S_6	H=R=	0·007		H=	0·094		H=	0·426		H=	0·421
	κ=ζ=	58°·34		κ=	95°·09		κ=	142°·50		κ=	212°·97
S_8	H=R=	0·002	O_1	R=	0·253	N_2	R=	1·037	$(2SM)_2$	R=	0·180
	κ=ζ=	115°·20		ζ=	102°·66		ζ=	162°·80		ζ=	248°·76
				H=	0·297		H=	1·006		H=	0·175
				κ=	33°·14		κ=	114°·89		κ=	60°·69
M_1	R=	0·042	K_1	R=	0·605	λ_2	R=	0·210	$2N_2$	R=	0·112
	ζ=	100°·05		ζ=	142°·84		ζ=	197°·72		ζ=	6°·19
	H=	0·029		H=	0·666		H=	0·203		H=	0·108
	κ=	125°·52		κ=	37°·34		κ=	142°·95		κ=	82°·29
M_2	R=	5·761	K	R=	0·430	ν_2	R=	0·395	$(M_2N)_4$	R=	0·163
	ζ=	302°·75		ζ=	194°·62		ζ=	247°·07		ζ=	256°·04
	H=	5·588		H=	0·543		H=	0·383		H=	0·154
	κ=	130°·82		κ=	162°·77		κ=	137°·99		κ=	36°·21
M_3	R=	0·025	P_1	R=	0·134	μ_2	R=	0·508	$(M_2K_1)_3$	R=	0·110
	ζ=	229°·22		ζ=	298°·02		ζ=	272°·03		ζ=	19°·89
	H=	0·024		H=	0·134		H=	0·478		H=	0·118
	κ=	151°·33		κ=	49°·33		κ=	288°·18		κ=	102°·46
M_4	R=	0·469	J_1	R=	0·029	R_2	R=	0·096	$(2M_2K$	R=	0·119
	ζ=	152°·39		ζ=	264°·11		ζ=	247°·48		ζ=	294°·41
	H=	0·441		H=	0·034		H=	0·096	$)_3$	H=	0·124
	κ=	168°·54		κ=	37°·70		κ=	125°·23		κ=	56°·06

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·309	138°·90	0·279	14°·88
„ Fortnightly „	0·160	258 ·63	0·228	45 ·75
Luni-Solar „ „	0·558	234 ·29	0·541	46 ·21
Solar-Annual „	1·405	178 ·35	1·405	157 ·04
„ Semi-Annual „	0·174	43 ·15	0·174	0 ·53

The mean level of the water is 14·925 feet above the zero of the gauge; this is the lowest value during the whole 4 years of observations, but it only differs from the highest value by ·15 of a foot or under 2 inches.

The mean amplitude (H) of the main lunar tide (M_2) is 5·588 feet, which is not very different from any of the three former values; it is the greatest value yet obtained, and differs from the 1881-82 value (the least) by ·07 of a foot or under 1 inch. Its epoch appears well determined, the greatest discrepancy between any 2 of the 4 years being 1°·4 or under 3 minutes in time.

The main solar tide (S_2) has an amplitude for this year 1·995, which is the least value yet obtained, whereas in the case of the main lunar tide, the amplitude this year was the greatest yet found. But the amplitudes of the main solar tide at Rangoon are in reality very accordant in all 4 years; the greatest discrepancy being ·030 of a foot or only about ½ of an inch. The epoch of this tide is also well determined, the greatest difference between any 2 values of the 4 years being 1°·81 or about 3½ minutes in time.

With regard to the lunar elliptic tides, the larger component (N_2) is 18 per cent. of the Main Tide, which agrees with the three former values, and is practically the same as the theoretical proportion which is 19 per cent. The smaller component (L_2) is 8 per cent. of the Main Tide; theoretically it should only be 3 per cent., but from the 4 years' observations at Rangoon, this tide varies from 6 to 9 per cent. of the Main Tide. The epoch of the principal component (N_2) is well determined at Rangoon, the greatest discrepancy between any 2 of the 4 years' values being about 4½° or nearly 9 minutes in time. The epoch of the smaller component (L_2) does not seem well determined yet at Rangoon, for although the first 3 years' values agree very well *inter se*, there is a difference of over 17° between the values of this year and last year.

The evectional tides (ν_2 and λ_2) are respectively, 7 and 4 per cent. of the Main Tide; theoretically they should be 4 and 1 per cent. There is a considerable fluctuation in the values of the epochs determined for these 2 tides during the 4 years of the observations.

The luni-solar semi-diurnal tide (K_2) is 10 per cent. of the Main Tide, which agrees with the 3 former values; theoretically it should be 13 per cent. The epoch of this tide has been fairly well determined at Rangoon, the values in the 4 years being tolerably accordant.

The lunar elliptic tide of the 2nd order ($2N_2$) has been analysed for the first time at Rangoon; it is ·019 of the Main Tide, which is not very different from the theoretical value 0·026.

With regard to the diurnal tides, their proportions to the Main Tide as compared to the theoretical proportion are as follows:—

		1883-84.	Theoretical.
Luni-Solar	(K_1)	0·119	0·584
Lunar Declinational	(O_1)	·053	·415
Solar „	(P_1)	·024	·193
„ Elliptic	(Q_1)	·008	·080
Lunar „	(J_1)	·006	·033
„ Diurnal	(M_1)	·005	·037

Thus it will be seen that the last 3 diurnal tides at Rangoon are perfectly insignificant as was found to be the case in the values obtained for the 3 former years; and for the 3 tides K_1, O_1, P_1 the proportions now obtained at Rangoon are all very much smaller than the theoretical values, but they agree well with the proportions obtained in the 3 former years. The epochs of the 3 largest diurnal tides K_1, O_1, P_1 are all fairly well determined at Rangoon. The significant overtides at Rangoon are the lunar and solar quarter-diurnal, also the lunar sexter-diurnal. The lunar quarter-diurnal tide is 8 per cent. of the Main Tide and the solar quarter-diurnal 2 per cent., the lunar sexter-diurnal is 4 per cent. of the Main Tide, and these values are exactly in accordance with what was found in the 3 former years. The epochs of the significant overtides M_4, S_4, M_6 are all very accordant in the 4 years' observations which have been reduced.

With reference to the long period tides, the lunar monthly is ·050 of the Main Tide against ·046 the theoretical value, but this tide has always been found to agree fairly well with the theoretical proportion in its value to the Main Tide at Rangoon.

The lunar fortnightly is ·041 of the Main Tide; this is much the same as the 3 former values, and is about one-half of what it ought to be theoretically.

The luni-solar fortnightly tide is 10 per cent. of the Main Tide, which is the same proportion as obtained in the 3 former years; theoretically this tide is quite insignificant, as it should be less than 1 per cent. of the Main Tide. The epoch of this tide is well determined at Rangoon, the greatest discrepancy in the 4 years being about 6° or within 6 hours in time.

The solar annual tide is 25 per cent. of the Main Tide, which is in accordance with the 3 former values; its epoch this year is about 4 or 5 days later than was found in the two previous years; its time of maximum would appear to be between the middle and end of August or the time at which the freshets in the river are strongest.

The solar semi-annual tide is ·031 of the Main Tide, which is precisely the same proportion as was obtained last year, and also, it may be said, as was found in 1880-81; but the value in 1881-82 was quite different, there being no appreciable tide of this period for that year. The epoch of the semi-annual tide varies considerably at Rangoon, the greatest difference between any two of the 4 values being 58,° or a discrepancy of 29 days. Its time of maximum would appear to be about the 5th September and 5th March.

VALUES OF THE TIDAL CONSTANTS, AMHERST, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Amherst; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short Period Tides.

A_o=13·757 feet.

S_1	H=	0·124	M_6	R=	0·153	Q_1	R=	0·015	T_2	R=	0·074
	$\kappa=\zeta$=	120°·19		ζ=	14°·37		ζ=	228°·30		ζ=	136°·76
S_2	H=R=	2·680		H=	0·138		H=	0·018		H=	0·074
	$\kappa=\zeta$=	100°·39		κ=	254°·39		κ=	10°·61		κ=	284°·28
S_4	H=R=	0·080	M_8	R=	0·018	L_2	R=	0·393	$(MS)_4$	R=	0·301
	$\kappa=\zeta$=	108°·12		ζ=	18°·80		ζ=	182°·54		ζ=	112°·75
S_6	H=R=	0·008		H=	0·016		H=	0·362		H=	0·291
	$\kappa=\zeta$=	327°·53		κ=	218°·83		κ=	81°·05		κ=	72°·76
S_8	H=R=	0·003	O_1	R=	0·282	N_2	R=	1·272	$(2SM)_2$	R=	0·182
	$\kappa=\zeta$=	301°·83		ζ=	75°·28		ζ=	219°·24		ζ=	325°·23
				H=	0·339		H=	1·230		H=	0·176
				κ=	344°·72		κ=	52°·12		κ=	5°·22
M_1	R=	0·016	K_1	R=	0·641	λ_2	R=	0·191	$2N_2$	R=	0·280
	ζ=	163°·81		ζ=	314°·85		ζ=	37°·83		ζ=	317°·37
	H=	0·014		H=	0·714		H=	0·185		H=	0·271
	κ=	88°·34		κ=	2°·90		κ=	91°·65		κ=	23°·10
M_2	R=	6·592	K_2	R=	0·683	ν_2	R=	0·442	$(M_2N)_4$	R=	0·290
	ζ=	106°·05		ζ=	185°·29		ζ=	2°·48		ζ=	62°·76
	H=	6·376		H=	0·883		H=	0·428		H=	0·271
	κ=	66°·06		κ=	100°·63		κ=	48°·67		κ=	215°·64
M_3	R=	0·022	P_1	R=	0·207	μ_2	R=	0·293	$(M_2K_1)_3$	R=	0·010
	ζ=	334°·62		ζ=	46°·02		ζ=	29°·98		ζ=	272°·31
	H=	0·021		H=	0·207		H=	0·274		H=	0·011
	κ=	274°·63		κ=	2°·59		κ=	309°·99		κ=	280°·38
M_4	R=	0·324	J_1	R=	0·019	R_2	R=	0·033	$(2M_2K_1)_3$	R=	0·038
	ζ=	117°·00		ζ=	192°·93		ζ=	314°·13		ζ=	77°·10
	H=	0·303		H=	0·022		H=	0·033		H=	0·039
	κ=	37°·02		κ=	10°·63		κ=	346°·62		κ=	309°·06

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·122	214°·72	0·109	341°·86
„ Fortnightly „	0·056	6 ·51	0·083	327 ·64
Luni-Solar „ „	0·054	94 ·30	0·052	134 ·29
Solar-Annual „	0·739	15 ·84	0·739	149 ·27
„ Semi-Annual „	0·161	200 ·50	0·161	107 ·36

The mean level of the sea (A_o) for this year is 13·757 feet above the zero of the gauge which corresponds very well to the mean value of the 3 previous years.

The mean amplitude (H) of the main lunar tide is 6·376 feet, which is very accordant with last year's value, but is considerably higher than that of either of the 2 previous years. The epoch of this tide at Amherst varies from 66° to 69° in the 4 years of observations which have been reduced.

The proportion of the main solar to the main lunar tide for this year at Amherst is 42 per cent; last year it was 43 per cent, and in the 2 previous years it was 45 and 46 per cent. the theoretical proportion being ·465.

The epoch of the main solar tide at Amherst appears to be somewhat variable; but if we neglect the 1880-81 value the greatest discrepancy in the last 3 years is 4° or about 8 minutes in time.

With regard to the luni-solar semi-diurnal tide, the proportion of its amplitude to that of the main lunar tide is ·138, which is the nearest value to the theoretical proportion (·127) yet obtained at Amherst. In former years the values obtained appeared to be somewhat variable.

The larger component (N_2) of the lunar elliptic tides agrees in its proportion to the Main Tide with the theoretical value, *viz.*, ·193, while the smaller component (L_2) is twice

as great as it ought to be, and this may be said to have been the case in the two previous years.

Regarding the evectional tides, the larger component (ν_2) is twice as great as it ought to be in proportion to the Main Tide, and the smaller component (λ_2) which ought by theory to be insignificant, is 4 times as great as its proper value.

The lunar elliptic tide of the 2nd order ($2N_2$) is ·043 of the Main Tide, as is also the variational semi-diurnal tide (μ_2), whereas each of those tides should be about ·025 of the main lunar tide.

Regarding the diurnal tides, they follow what has been noticed with regard to all these tides in the Bay of Bengal in being very much smaller in proportion to the Main Tide than the values which theory would give; indeed at Amherst several of those tides which ought to have a considerable value are perfectly insignificant.

The following shows the proportions between the 1883-84 and the theoretical values at Amherst of the diurnal tides, in comparison to the main lunar tide:—.

		1883-84.	Theoretical.
Luni-Solar	(K_1)	·112	·584
Lunar	(M_1)	·002	·036
Solar Declinational	(P_1)	·032	·193
Lunar do	(O_1)	·053	·415
Lunar Elliptic	(J_1)	·003	·033
Solar Elliptic	(Q_1)	·003	·080

But the values at Amherst for all the 4 years are very accordant, and this may be also said of the epochs of K_1 the only significant diurnal tide.

Regarding the overtides at Amherst the quarter-diurnal lunar is of course the largest, being ·048 of the Main Tide; this value is a little less than that obtained in the two previous years, but agrees with the 1880-81 value. The value of this tide obtained in 1881-82 was as large as 7 per cent of the Main Tide. The next largest overtide at Amherst is the sexter-diurnal lunar (M_6), which is ·072 of the Main Tide, a value which is very accordant with the two preceding years' values.

The only solar overtide of importance is the quarter-diurnal which is ·013 of the Main Tide, a value which agrees very well with the proportions obtained in the three preceding years.

Referring now to the long period tides, the lunar monthly is ·017 of the Main Tide against ·046, the theoretical value.

The lunar fortnightly is ·013 of the main lunar tide, while the theoretical value is more than 6 times as great, being ·086. But the luni-solar fortnightly tide is quite insignificant, as it should be.

With regard to the solar annual tide the amplitude is 12 per cent. of the main lunar tide, which is less than $\frac{1}{4}$th of the magnitude of this tide at Moulmein: its epoch at Amherst is about 143°, while at Moulmein it is 150°, showing the times of maximum to be the 14th and 21st August, at Amherst and Moulmein respectively, which corresponds with the middle of the south-west monsoon, when the river is in heavy flood. This shows the tide to depend on the freshets and therefore to be meteorological in its origin.

The solar semi-annual tide is ·025 of the Main Tide or about $\frac{1}{4}$th of the value which obtains at Moulmein; its epoch is very variable at Amherst, while at Moulmein its time of maximum is well determined and is about the middle of the south-west monsoon.

VALUES OF THE TIDAL CONSTANTS, PORT BLAIR, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short Period Tides.

A_0=4·766 feet.

S_1	H—R =	0·015	M_6	R =	0·007	Q_1	R =	0·009	T_2	R =	0·037
	κ—ζ =	85°·49		ζ =	306°·35		ζ =	284°·49		ζ =	109°·70
S_2	H—R =	0·975		H =	0·007		H =	0·011		H =	0·037
	κ—ζ =	316°·24		κ =	165°·55		κ =	255°·88		κ =	354°·65
S_4	H—R =	0·004	M_8	R =	0·001	L_2	R =	0·095	MS_4	R =	0·004
	κ—ζ =	108°·44		ζ =	148°·00		ζ =	248°·29		ζ =	110°·38
S_6	H—R =	0·003		H =	0·001		H =	0·093		H =	0·004
	κ—ζ =	175°·60		κ =	80°·27		κ =	287°·72		κ =	183°·44
S_8	H—R =	0·001	O_1	R =	0·134	N_2	R =	0·394	$(2SM)_2$	R =	0·017
	κ—ζ =	220°·60		ζ =	174°·51		ζ =	354°·71		ζ =	213°·12
				H =	0·159		H =	0·382		H =	0·017
				κ =	302°·20		κ =	271°·57		κ =	140°·06
M_1	R =	0·006	K_1	R =	0·356	λ_2	R =	0·037	$2N_2$	R =	0·016
	ζ =	161°·24		ζ =	25°·07		ζ =	191°·56		ζ =	120°·42
	H =	0.004		H =	0·393		H =	0·036		H =	0·044
	κ =	312°·86		κ =	327°·52		κ =	216°·41		κ =	240°·90

Short Period Tides—(continued).

A_0=4·766 feet.

M_2	R=	2·078	K_2	R=	0·218	ν_2	R=	0·021	$(M_2N)_4$	R=	0·039
	ζ=	205°·74		ζ=	251°·22		ζ=	31°·20		ζ=	176°·31
	H=	2·013		H=	0·277		H=	0·020		H=	0·037
	κ=	278°·81		κ=	315°·28		κ=	332°·49		κ=	166°·15
M_3	R=	0·010	P_1	R=	0 132	μ_2	R=	0·079	$(M_2K_2)_3$	R=	0·023
	ζ=	94°·92		ζ=	260°·80		ζ=	16°·88		ζ=	309°·38
	H=	0·009		H=	0·132		H=	0·074		H=	0·025
	κ=	24°·52		κ=	328°·81		κ=	315°·01		κ=	324°·89
M_4	R=	0·014	J_1	R=	0·018	R_2	R=	0·022	$(2M_2K_2)_4$	R=	0·003
	ζ=	312°·61		ζ=	195°·17		ζ=	334°·49		=	25°·77
	H=	0·013		H=	0·021		H=	0·022		H=	0·003
	κ=	98°·75		κ=	296°·85		κ=	260°·54		κ=	229°·46

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·011	238°·39	0·010	34°·68
„ Fortnightly „	0·037	15·72	0·053	13·41
Luni-Solar „ „	0·014	105·77	0·014	32·70
Solar-Annual „	0·218	152·85	0·218	179·84
„ Semi-Annual „	0·153	122·55	0·153	176·54

The mean level of the sea (A_0) is 4·766 feet above the zero of the gauge, which is about half a tenth higher than the value obtained in each of the 2 former years, but is three hundredths of a foot lower than the 1880-81 value.

The mean amplitude (H) of the main lunar tide is 2·013 feet, which is almost identical with the value found for the 2 previous years, but is about 0·03 foot less than the 1880-81 value; the epoch of this tide seems very well determined at Port Blair, as the greatest discrepancy between any two of the 4 years' values is under 2° or less than 4 minutes of time.

The proportion of the main solar to the main lunar tide is 0·484, which is accordant with the 3 previous values; the mean of all the 4 years' proportions is 0·480, which is slightly too great according to theory, as 0·465 is the theoretical proportion of S_2 to M_2. The epoch of this tide also is well determined at Port Blair, the greatest difference between any 2 of the 4 years' values being under 3° or about 5 minutes in time.

With regard to the lunar elliptic tides, the larger component (N_2) has the same proportion to the Main Tide as theory would assign, and this was precisely the case in the two former years and also practically what was found in 1880-81. The smaller component (L_2) is 0·046 of the Main Tide; last year it was 0·023, while in 1880-81 it was 0·029; theoretically it should be 0·028; this has the appearance, that every alternate year the theoretical proportion is obtained while in the intermediate years this tide is twice as large as it should be. The epoch of the main component, (N_2) is very fairly accordant in all 4 years analysed, the greatest difference between any 2 years being about 5°; but for the lesser component (L_2), the epoch is not well determined, there being as much as 32° difference between the greatest and least values in the 4 years.

Regarding the evectional tides, the greatest component (ν_2) is much smaller in proportion to the Main Tide than the theoretical value, being only 0·010, while theory would assign 0·038. Last year the theoretical proportion was obtained, but in the two former years the proportions found were considerably larger than they ought to be, *viz.*, 0·068 and 0·072; thus it will be observed there is a great fluctuation in the values of the amplitude obtained for this tide. In the smaller component however the proportion to the Main Tide is fairly accordant in all 4 years, and is about 3 times too large according to theory, but this tide is theoretically quite insignificant. The epochs which have been obtained for both these tides are subject to a very large fluctuation year by year and cannot be considered well determined.

The luni-solar semi-diurnal tide (K_2) is 0·138 of the Main Tide, which is nearly the same as was found in each of the 3 preceding years; theoretically it should be 0·127. The epoch of this tide is very consistent in all the 4 years analysed, the greatest discrepancy between any two values being 7°·5.

The variational tide (M_4) is 0·337 of the Main Tide, which is precisely what was obtained last year: the proportion in the 2 former years being about 0·045; theoretically it should be 0·024. The values of the epoch are not consistent in the 4 years analysed, so it cannot be considered well determined.

The lunar elliptic tide of the second order ($2N_2$) has been analysed for the first time at Port Blair; its proportion to the Main Tide is 0·022; theoretically it should be 0·026.

Regarding the diurnal tides the values obtained for the amplitudes all agree well with the 3 former values, but the proportions to the Main Tide are very different from the values

theory would give; the proportions obtained for 1883-84 and the theoretical proportions are as follow :—

		Value for 1883-84.	Theoretical value.
Luni-Solar	(K_1) . . .	0·195	0·584
Luni-Declinational	(O_1) . . .	·079	·415
Solar do	(P_1) . . .	·066	·193
Lunar elliptic	(J_1) . . .	·010	·033
Solar do	(Q_1) . . .	·005	·030
Lunar Diurnal	(M_1) . . .	·002	·036

It will thus be seen that the proportions obtained are all much smaller than they ought to be, the last 3 tides being absolutely insignificant. The small value of the Diurnal Tides is one of the peculiar features of the Tide at Port Plair, and the same thing is noticed at all the stations in the Bay of Bengal.

The epochs of the 3 significant diurnal tides are all very well determined at Port Blair, the values for the different years being very accordant in all 3.

At Port Blair there may be said to be no overtides this year, and the same remark applies to former years, as the values obtained for all the lunar and solar overtides are quite insignificant.

With regard to the long-period tides: the lunar monthly is quite insignificant, and this has always been found at Port Blair, while theory gives the proportion of this tide to the Main Tide as 0·046.

The luni-solar fortnightly is, as it should be, quite insignificant: theoretically this tide should be 0·007 of the Main Tide, which is the value obtained for this, and it may be said, for former years also.

The lunar fortnightly is this year 0·026 of the Main Tide, which agrees closely with the proportions found in the 3 former years; but theoretically it should be 3 times as great, *viz.*, 0·086 of the Main Tide.

The solar annual tide is this year 11 per cent. of the Main Tide, last year it was 13 per cent. and in 1880-81 it was 15 per cent.; all these are fairly accordant values, but in 1881-82 the solar annual tide was very small, being only 3 per cent. of the main lunar tide. Its epoch this year is 21 days later than was found last year, which brings the time of maximum to about the 16th or 17th September, and this points to the tide being meteorological in origin, with the time of its maximum towards the latter part of the south-west monsoon.

The semi-annual tide is 0·076 of the Main Tide. This is higher than has hitherto been found at Port Blair, but the values are not very divergent in the several years; its epoch appears to fluctuate about 15 days and the value obtained this year is a fair mean of the whole, which would give the times of maximum about the 18th June and 18th December.

Extract from the Narrative Report of Major W. J. Heaviside, R.E., *Deputy Superintendent, 2nd grade, in charge Astronomical Parties Nos. 1 and 2,—season 1884-85.*

Astronomical latitudes have not been observed with the Zenith Sectors since 1871-72.

The sectors are numbered 1 and 2, and on the last occasion on which they were used No. 1 gave what has generally been called in this Department a large (N-S) error, or in other words a larger value of latitude by stars north than by stars south of the Zenith. The Zenith Sector (No. 2) was sent up from Calcutta to Sháhjahánpur by rail, and on arrival it was found that the levels had been broken in transit: there were spare levels, but they were not mounted and appeared to me to have no marks on them to indicate where the curves lay; so I telegraphed to Calcutta for the two levels belonging to No. 1 Sector which were promptly sent up by Major Rogers. I found too that the bubble of the transit axis level had become too long to be read, so I had to fit a new tube to it and all these refittings proved very troublesome. While they were going on, I had a pillar built in order that I might set up the sector to see whether it had met with any further damage, and also with a view to practise the manipulation of the instrument of which I had very little previous knowledge. Mr. Prunty too had to be instructed in the best methods of laying down the positions for the latitude stations by star observations. On the 19th November, having learnt all that was necessary, he started for Jarúra which for many reasons was considered by me the best station to commence at. I remained at Sháhjahánpur a few days longer, practising with the instrument, and was unable to detect that it had received any damage beyond the breakage of the levels. On the 23rd I followed Mr. Prunty, and on arrival at Jarúra on the 27th, I found that he had not completed the pillars for the instrument; this however I had anticipated, and I wished to be present with him at this the first station to see that he understood his instructions. On the 3rd of December the sector was erected, and Mr. Prunty started on the 4th to build the pillars at the next station Rámuápúr. I continued for some days taking a series of observations merely for practice; the sector is a very difficult instrument to master, and it was not until the 17th that I felt myself sufficiently acquainted with it to commence a regular series of observations

which was completed on the 21st. The following table shows the dates of my arrival at, and departure from, each of the eight stations at which I observed :—

Stations.	Latitude.	Date of arrival.	Date of departure.
Jarún T. S.	28° 0′	November 27th.	December 22nd.
Rámuápúr T. S.	28 22	December 26th.	January 9th.
Nimkár T. S.	27 21	January 16th.	„ 25th.
Etora T. S.	26 54	„ 28th.	February 2nd.
Dewarsán T. S.	26 16	February 20th.	„ 26th.
Kánákhora T. S.	25 51	March 3rd.	March 11th.
Pavia H. S.	25 27	„ 15th.	„ 22nd.
Potenda P. S.	24 37	April 2nd.	April 11th.

The programme for each station was arranged for 30 stars, one half north the other half south of the zenith, the sum of the zenith distances of the north stars being nearly equal to that of the south stars. An observation was not considered complete unless the star was observed on the same night in the two positions with Telescope East and with Telescope West; each star was to be observed on four nights, two with the azimuthal stud of the sector north and two with the stud south, the two positions of the stud representing a revolution of the pillar of the instrument through an angle of 180°. In practice, owing to cloudy weather, a station was seldom completed in four nights, and the number of observations at a station average 125. At the first station two collimator pillars were built and the collimators set up on them one to the north the other to the south. This however is not a good arrangement, and subsequently either a referring mark or collimator pillar was built to the north, and in the former case two lamps, in the latter two collimators were set up 9·6 inches on each side of the meridian so as to be opposite to the telescope in the two positions of the instrument, Telescope East or Telescope West. This was found to save a great deal of time and should always be adopted in future. The collimators can be relied on to check the position of the telescope with regard to the meridian when circumpolar stars are not visible, and moreover they immensely facilitate the re-adjustments of the instrument when the pillar is moved bodily round from stud north to stud south.

The Levels.—The runs of the levels had been determined by Captain Campbell in 1870, but they were re-determined by me first at Rámuápúr and secondly in Calcutta. One of them No. 3 gave rather variable results, and its indications on the instrument, when compared with No. 2, were found to differ considerably. This and some other little matters, such as the stiffness of the rollers under the telescope, which are acted on by one of the counterpoise weights, induced me when I got to the railway at Cawnpore, after completing four stations, to obtain permission to take the sector to Calcutta, where Mr. Bolton designed a dust trap which was much required to protect the upper part of the vertical axis; the collar carrying the relieving rollers was found to be slightly bent, and was taken out, straightened, and thoroughly cleaned. Owing to the performance of No. 3 level I obtained No. 4 in Calcutta and determined there a value of the run of each of the three levels Nos. 2, 3, 4 with the bubble-tester. These values were found to agree well with the values previously determined by Captain Campbell, but the bubble of No. 3 showed a bias towards certain points of the scale, and consequently No. 4 was mounted on the sector, in its place, and the results obtained during the remainder of the field season showed a much closer agreement in the indications by the two levels, Nos. 2 and 4, than had existed before with Nos. 2 and 3.

I may add that I have written in the Observatory Memo. Book minute details of all I can think of that may be useful to any new hand who takes up work with the Zenith Sector in the future including the building and selection of stations in advance by the assistant.

As regards the general incidents of the field season there is little to record. Down to Pavia we were in the flat healthy districts of Oudh or the North-Western Provinces. After leaving Pavia and passing through Kirwi we got into some rather rough country, striking the railway at Manikpur; beyond towards Sutna there was but a path-way through the jungle, where the *kahars* (carriers) had great difficulty in carrying the Zenith Sector boxes, so I railed most of the things on to Sutna. The last station Potenda was in the Rewah territory near the large town of Mádhogarh, and I would here acknowledge the invariable courtesy of the Darbar officials with whom Mr. Prunty and I came in contact and the assistance they rendered to us.

The triangulation of the Amúa series was carried out in 1838-39 when it was the custom to use upper markstones which were not permanently fixed, and in general these stones have not been found. The towers, constructed for the most part of unburnt bricks, were usually irregular in shape and it was necessary to dig down, sometimes 20 feet, to get at the lower markstones. These towers as a rule proved uncommonly tough, but the lower markstones have always been found in position and are of gigantic size usually set in a course of stones with mortar so that there is no doubt about them. The only exception is the station of Dewarsán where the upper mark was found cut on a block of red sandstone projecting some 6 inches above the tower. This is so unusual and so unlike the other stations of the series that it excited my suspicions, more especially as the tower was neatly plastered and quite in apple-pie order. The markstone was on the round tower of an old fort which would have been very difficult to cut through, and as the outline of the tower was a well-marked circle it was considered that the markstone was sufficiently exactly placed for all purposes of latitude observations.

Report on the Geographical position of Mashhad by MAJOR T. H. HOLDICH, R.E., *Deputy Superintendent, in command of detachment, Survey of India, with the Afghan Boundary Commission, dated 12th August 1885.*

The necessity of securing a well fixed point on which to close the long series of survey operations, extending over 1,000 miles from India, as well as to secure an initial value for the future extension of geographical surveys either eastwards or westwards, as the future movements of the Afghan Boundary Commission might determine, was so apparent that about the middle of April, Captain Gore, R.E., started from Tirpul to Mashhad for the purpose of fixing such a point if possible. Mashhad was selected partly because it is the terminus of the Persian Telegraph Line from Tehrán, and it thus offers the best possible chance of an accurate determination of longitude differentially from Tehrán, and partly because it is apparently within the limits of Russian geodetical operations. Although Captain Gore left in April for this duty, it was not until the end of June that he finally succeeded in obtaining satisfactory results, owing both to the unusual continuance of atmospheric disturbances between Mashhad and Tehrán, combined with the incessant presence of clouds at the latter place which prevented time observations from being taken, and to the constant collapse of the Persian telegraph which was by no means in perfect working order. His final success was due to the very able assistance of General Schindler (Director-General of Persian Telegraphs) at Tehrán, who spared no pains towards rendering the results as accurate as possible. Of his own observations at Tehrán General Schindler writes thus :—

"At last on Saturday the 20th we were able to exchange time signals, I had observed five nights before the 20th and one night after it. Every night I took three sets of ten observations each of an eastern, and three sets of ten observations each of a western star. The greatest difference between the eastern and western results was 0·190 second. The chronometer here is very old, and is a chronometer no more. For instance in the 24 hours between my first and second observation nights it lost 1·453 seconds, in the second 24 hours 1·612 seconds, in the third 1·374 seconds and in the fourth 1·205 seconds. After the exchange of time signals I observed again and found that the chronometer had lost 2·381 seconds in 48 hours. Altogether I do not think that the possible error here exceeds 0·30 seconds, and as Captain Gore's error will probably be much less the final result for the longitude of Mashhad ought to be right within 7 to 9 seconds of arc. Captain Gore's result 59° 35′ 52″·3 proves that I was right in thinking the longitudes obtained by the later Russian observers to be too far east. Fraser's 59° 35′ 27″ (for a place in the south-west corner of Mashhad) and Lemm's result (as corrected by St. John) 59° 36′ 15″ are very close."

Captain Gore's time values were obtained by observation with a 6-inch transit theodolite to east and west stars before, and after, the interchange of telegraphic signals. He reports that the actual chronometer comparisons consisted of three sets of three signals each sent from Tehrán, the times of receipt being recorded at Mashhad, and of three similar sets of three signals each sent from Mashhad, and received at Tehrán. All signals were break current signals. By sending in both directions the effects of retardation were eliminated from the mean result. The comparisons agreed well, and I do not think that there is a possible error of more than 0·15 second in the results from this source.

The observations for time were made by sets of observations to stars east and west, two stars being observed on each side the meridian, and the comparisons of chronometers were conducted on the afternoon of the 20th June, and the observations for time on the evenings of the 18th, 19th and 20th June, giving the following results :—

Chronometer errors.

	Star E.	Star W.	Mean.	Rate per 24 hours losing.
June 18th	1—10—43·8	1—10—44·5	1—10—44·05	
	44·1	43·8		
June 19th	1—10—40·6	1—10—40·3	1—10—40·43	3·620
	40·7	40·1		
June 20th	1—10—36·6	1—10—36·6	1—10—36·80	3·630
	37·1	36·9		

The results are sufficiently accordant, I think, to warrant the assumption that the error of the Mashhad chronometer was known within 0·2 second and probably much closer. Combining this with General Schindler's account of his work, my opinion is that the resulting longitude of Mashhad is correctly determined well within 0·5 second of time.

The latitude of Mashhad (Chaparkhána) was determined by circum-meridian observations taken with the same theodolite to six south stars, balanced by five sets of observations to Polaris out of the meridian, and one set of circum-meridian observations to a north star; the results being as follows :—

By south star.	By north star.	
36°—17′—41″	36°—17′—46″	
49	32	
50	38	General mean 36°—17′—42″
47	30	giving a probable error under
38	36	2 seconds.
42	50	

As the station at the Chaparkhána is not of absolute permanence the values of latitude and longitude have been transferred, by triangulation, to the centre of the Imám Reza Dome the final result being Mashhad Imám Reza Dome $\frac{\text{Lat. } 36°-17'-19''\cdot 6}{\text{Long. } 59-36-14\cdot 4}$ E. from Greenwich.

The position of the Imám Reza Dome has also been fixed by triangulation extending from the Kuhsan base. The Kuhsan base is connected with the Indus Valley series of the Great Trigonometrical Survey of India by a long chain of survey operations, consisting of direct triangulation as far as Rudbár on the Helmund; traverse from Rudbár to Chahár Burjak, where the route turned northward, and from thence connected triangulation either from short independent bases or from bases fixed by observations for latitude and azimuth, to Kuhsan on the Hari Rud. The length of traverse was about 35 miles, and in this traverse will the resulting difference of longitude between the values brought up from India and Gore's value at Mashhad be dispersed. Apparently this is small (well within 15 seconds of arc) but its final determination will rest with the final revision of the triangulation. I may mention that the longitudinal values derived from Russian sources appear to be (as suggested by General Schindler) too far east but the invariable absence of any exact description enabling one to identify the station of observation leaves the question entirely open. Mashhad is a large town, larger than Herát, and about as large as Kandahár. A geographical position simply described as Mashhad is of no practical value.

DRAWING OFFICE, CALCUTTA.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILING.

Statement showing the work performed and the progress made from 1st October 1884 to 30th September 1885.

TITLE OF MAP.	Number of Sheets.	Scale. In. Mls.	REMARKS AND PROGRESS.
India Railway Map	6	1¼ = 32	Brought up to date.
„ Canal Map	6	1 = 32	A new edition is being prepared.
„ Skeleton Map	6	1 = 32	Showing only large rivers, cities and principal hill ranges.
„ Engraved Map	6	1 = 32	Fresh material in Afghanistan and Baluchistan added.
„ Engraved Map Skeleton	2	1 = 64	Railways completed and in progress, brought up to date.
„ Percentage of Cultivation	20	1 = 64	Prepared at the request of Officiating Secretary to Government, Revenue Department, for the Indian and Colonial Exhibition of 1886—in progress.
Country on either side North-West Trans-frontier (in two sheets).	2	1 = 32	Prepared at the request of Secretary to Government, Public Works Department, comprises country between latitude 24 to 40 and longitude 64 to 70.
Mysore Province	1	1 = 16	A new compilation from the recent 1″=1 mile Topographical Survey; first edition will be photozincographed but will ultimately be engraved.
Kohat District	1	1 = 8	From latest topographical surveys; first edition will be photozincographed, but will ultimately be engraved.
Punjab	4	1 = 16	Completed and sent to engraving office.
Rajputana Agency	2	1 = 16	Additions up to date in outline and hill shading.
Gujarát	1	1 = 16	A compilation from recent surveys; will include Gujarát, Kathiáwár and Cutch; will be engraved.
Central India Agency	2	1 = 16	Additions up to date in outline and hills.
Provincial Map of Bengal	2	1 = 16	Hills, shaded for engraving office.
North-West Trans-frontier sheets 11, 10, and 18.	3	1 = 8	From routes and surveys by Boundary Demarcation Commission published in preliminary form from latest surveys.
North-West Trans-frontier sheets 22 N. E., 28 S. W., 29 S. W.	5	1 = 4	Ditto ditto ditto ditto.
North-West Trans-frontier sheets 29 N. W., 30 N. W.			A second edition of 30 N. W. will be published shortly.
North-West Trans-frontier sheets 29 S. E. / 1, 2	2	1 = 2	Ditto Ditto Ditto Ditto.
North-West Trans-frontier sheets 30 S. W. / 2, N. W. / 3	2	1 = 2	In complete sheets.
North-West Trans-frontier sheets 22 N. E. / 4, S. E. / 2	2	1 = 2	
Central India sheets Nos. 97, 367, 368, 369, 385, 386, 387, 388, 399, 400, 401, 402, 403, 404, 405, 412, 413, 414, 415, 416, 417, 422, 423, 424.	24	1 = 1	New edition, numbered according to Central India and Rajputana index, completed to margin including portions of North-Western Provinces Nos. 97, 367, 368, 369, 386, 387, 383, 399, ... have been drawn and photozincographed, Nos. 358, 400, 401, 403, 404, 412, 413, 414, 416, 417, 422, are far advanced in drawing, Nos. 385, 402, 405, 415, 423, 424, ... are not yet taken up.
Mysore Standard sheets 18 and 50	2	1 = 1	New boundaries entered and additions made to roads and railways.
Route to and from Baila	1	1 = 6	Reproduced by photozincography.
Route from Nasiki to Gazachack by Captains Gore and Talbot.	1	1 = 8	Reproduced by photozincography.
Sheet No. 12, Afghanistan.		1 = 4	Drawn for the use of the Boundary Commissioner.
Biglot Map of Afghanistan by Quarter Master General.	1	1 = 14½	Hills drawn for use of Boundary Commissioner.
Southern Afghanistan and part of Baluchistan.	1	1 = 8	Inserted additions and supplied in duplicate for use of Boundary Commissioner.
Skeleton Map, British Islands	1	1 = 32	Drawn for insertion on maps of India.
„ „	1	1 = 128	
Simla Revision Survey sheets 1, 2, 3, 6, 7, 8, 12, and 13.	8	24 = 1	Fair sheets drawn for photozincography; first edition without contours.
Simla Guide Map	1	8 = 1	New edition, reduced copy of above.
Punjab		1 = 64	For Financial Commissioner's Annual Report.
Postal Map of Bengal	11	1 = 8	Prepared for the Post Master General.
Sheets of the Atlas of India.			
3 S. W.	1	1 = 4	Outline and names as far as materials available, for engraving.

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SECTION I—*continued.*

TITLE OF MAP.	Number of Sheets.	Scale. In. Mls.	REMARKS AND PROGRESS.
Sheets of the Atlas of India, contd.			
4A. N. E.	1	1 = 4	Outline and names as far as materials vailable, for engraving.
4 S. E.	1	1 = 4	Hills in vertical shading, for lithography.
11 S. W.	1	1 = 4	Outline and names as far as materials available, for engraving.
12 N.E.	1	1 = 4	Outline as far as materials available, for engraving.
12 S.W.	1	1 = 4	Hills and ravines in brush, for engraving.
12 N.W.	1	1 = 4	Ditto ditto.
15 N.E.	1	1 = 4	Outline and names, for engraving.
16 S.W.	1	1 = 4	Ditto ditto.
16 N.W.	1	1 = 4	Additions in outline and names, for engraving.
21 S.E.	1	1 = 4	Outline and names as far as materials available, for engraving.
28 Full plate	1	1 = 4	Hills in brush, for engraving.
31 N. W.	1	1 = 4	Corrections in boundaries of districts Hissar and Sirsa.
31 S. W.	1	1 = 4	
31 S. E.	1	1 = 3	Outline and names from late surveys, for engraving.
32 N. W.	1	1 = 4	Ditto ditto.
35 S. W.	1	1 = 4	Hills in brush, for engraving.
35 N. E.	1	1 = 4	Ditto ditto.
37 S. W.	1	1 = 4	Outline and names from latest surveys in Khándesh, for engraving.
37 S. E.	1	1 = 4	Hills in brush, for engraving.
38 N. W.	1	1 = 4	Outline and names from latest surveys in Khándesh, for engraving.
38 S. W.	1	1 = 4	Hills in brush, for engraving.
38 S. E.	1	1 = 4	Ditto ditto.
39 N. W.	1	1 = 4	Ditto ditto.
39 S. W.	1	1 = 4	Ditto ditto.
40 N. E.	1	1 = 4	Ditto ditto.
48 S. E.	1	1 = 4	Ditto ditto.
48 N. E.	1	1 = 4	Outline, names and sand hills, for engraving.
49 S. E.	1	1 = 4	Hills in brush, for engraving.
50 N. E.	1	1 = 4	Outline and names as far as available, for engraving.
51 S. E.	1	1 = 4	Additions in roads and canals.
52 N. E.	1	1 = 4	Ditto ditto.
67 S. W.	1	1 = 4	Outline and names from latest surveys, for engraving.
68 N. W.	1	1 = 4	Ditto ditto.
77 S. E.	1	1 = 4	Hills in brush, for engraving.
79 S. W.	1	1 = 4	Ditto ditto.
88 N. E.	1	1 = 4	Outline and names from latest survey, for engraving.
102 Full sheet	1	1 = 4	Canals, roads and railways, for engraving.
103 "	1	1 = 4	Ditto ditto.
114 S. W.	1	1 = 4	Outline, names, &c., &c., in progress.
District Maps.			
District Chanda	1	1 = 4	Prepared for lithography from transfers from copper-plates.
" Chhindwara	1	1 = 4	
" Rangpur	1	1 = 4	
" Cachar	1	1 = 4	
Administration Report Maps.			
Bengal Provincial Map	1	1 = 80	For Administration Report.
North-West Provinces	1	1 = 80	Ditto ditto.
Rajputana Agency	1	1 = 80	Ditto ditto.
British Burma and Pegu	1	1 = 80	Ditto ditto.
Assam	1	1 = 80	Ditto ditto.
Central Provinces	1	1 = 80	Ditto ditto.
Punjab	1	1 = 32	Ditto ditto.
Central India	1	1 = 80	Ditto ditto.
Central Provinces	1	1 = 32	For reproduction by photo to illustrate Sanitary Commissioner's Report.
PROVINCE OF PUNJAB— Districts Karnál, Dera Ghází Khan, Dera Ismail Khan, Ludhiána, Gurgaon, Lahore, Mooltan, Jhang, Jullundar, Amritsar, Kangra, Umballa, Gujarát, Peshawar, Gujránwála, Delhi, Rawalpindi, Montgomery, Jhelum, Bannu, Simla, Hazara, Ferozepore, Gurdaspur.	27	1 = 8	These district maps are specially prepared for Administration reports, in accordance with Surveyor-General's instructions, *vide* memorandum of 6th June 1884. They have been re-drawn from the 8-mile district maps or reduced from atlas sheets.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

TITLE OF MAP.	Number of Sheets.	Scale.	REMARKS AND PROGRESS.
		In. Mls.	
PROVINCE OF BENGAL—			
Districts Backergunge, Purneah, Bogra, Howrah, Pabna, Rajshahi, Hooghly, Furreedpore, Maldah, Moorshedabad, Burdwan, Bhagalpur, Jessore, Mymensingh, Gurjat States, Chota Nagpore, Lohardugga, Sargoja.	19	1 = 1 8	These sheets were prepared last year but have been redrawn for various reasons.
Baukoora, Jashpur, Rungpore, Chumparun, Dinagepore, Manbhoom, Julpigoree, Sarun, Mozufferpore, Morbhanj, Cuttack, Balasore, Midnapore, Shahabad, Chittagong, Chittagong Hill Tracts, Darjeeling, Sonthal Pargunas, Patna, Pooree.	21	1 = 8	
CENTRAL PROVINCES—			
Damoh, Narsinghpur, Bhandara, Nagpur, Nimar.	6	1 = 8	
N.-W. PROVINCES AND OUDH—			
Meerut, Lalitpur, Partabgarh, Aligarh, Mirzapur, Jalaun, Muttra, Saharanpur, Benares, Bilibhit, Ballia, Rai Bareli, Lucknow, Jhansi, Hamirpur, Kumaon, Mainpuri.	16	1 = 8	
Dehra Dún, Farukhabad, Bijnor, Tarái, Cawnpore, Bulandshahr, Jaunpur, Budaun, Bareilly.	9	1 = 8	These sheets were prepared last year but have been redrawn for various reasons.
ASSAM—			
Cachar	1	1 = 8	
Index Maps.			
Province Index British Burma .	1	1 = 24	Prepared in accordance with instructions of Surveyor-General.
Ditto Do. Assam . .	1	1 = 16	
Ditto Do. Sind . . .	1	1 = 16	In progress.
Ditto Do. Bombay . .	1	1 = 32	
Ditto Do. Madras . .	2	1 = 32	
Index to Trans-frontier of India .	1	1 = 128	
Do. North-West Trans-frontier	1	1 = 64	
Do. North Trans-frontier .	1	1 = 64	
Do. North-East Trans-frontier	1	1 = 64	
Do. South-East Trans-frontier	1	1 = 64	
Do. Nepal Frontier . .	1	1 = 4	
Do. Garo, Khasi and Naga Hills Survey.	1	1 = 24	
Do. Baluchistan Topographical Survey.	4	1 = 32	
Do. Burma Topographical Survey.	1	1 = 16	
Do. Cutch Topographical Survey.	1	1 = 18	
Do. Andaman Topographical Survey.	1	1 = 24	
Do. Gujarát Survey . .	1	1 = 24	
Miscellaneous.			
Burma and the regions adjacent	2	1 = 16	Corrected to date in railways, boundaries, &c.
District Sylhet . . .	1	1 = 4	
Do. Hoshangabad . .	1	1 = 4	
Do. Baukoora . . .	1	1 = 4	
Do. Dacca	1	1 = 4	
Do. Hamirpur . . .	2	2 = 1	

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

TITLE OF MAP.	Number of Sheets.	Scale.	REMARKS AND PROGRESS.
Miscellaneous.		In. Mls.	
Route map of Bengal	1	1 = 32	For use of Comptroller General.
Country round Rawalpindi	1	1 = 1	
Index to the Trans-frontier of India.	3	1 = 128	For Surveyor-General and for Deputy Surveyor-General, Trigonometrical Branch.
Standard sheet No. 6, Rewah	1	1 = 1	Hills and details touched up for photozincography.
India	1	1 = 128	Showing divisions, large rivers and railways only for Department of Revenue, Agriculture and Commerce, for hand-book to send to Anglo-Colonial Exhibition.
Calcutta	1	...	Showing municipal wards.
Map of Khartum and Environs	1	1 = 1½	For reproduction by photozincography.
Snow-peaks about Katmandu	1	1 = 8	Tracing supplied to Political Agent, Nepal.
Andaman Survey sheets	3	4 = 1	Printing Title, foot-notes.
Plan of Battle of Kandahar	1	1 = 4	Corrected for photo.
Originals and proofs corrected for photozincography, lithography, &c.	...	Various scales.	
Sheets of various maps colored as standard office copies	1,051	,,	
Maps Examined.			
Original Standard Sheets	15	4 = 1	Examined with plane-table sheets and carried out corrections for photozincography.
Ditto ditto	17	2 = 1	Ditto ditto ditto.
Ditto ditto	12	1 = 1	Ditto ditto ditto.
Ditto ditto	22	1 = 1	Mysore sheets. Examined corrections in territorial changes, &c.
Ditto ditto	5	1 = 2	Examined with plane-table sheets and carried out corrections.
Ditto ditto	10	1 = 4	Ditto ditto ditto.
Original Large Scale Plans	1	24 = 1	Examined with plane-table sheets for photozincography.
Ditto ditto	5	12 = 1	Ditto ditto ditto.
Ditto ditto	3	8 = 1	Ditto ditto ditto.
Original Triangulation Charts	2	2 = 1	Examined for photozincography.
Original Atlas sheets or portions thereof compiled in Drawing Office and received from Survey Parties.	59	1 = 4	Examined and carried out corrections for the Engraving Office.
General and Provincial Maps	2	1 = 16	Examined hills in brush for the Engraving Office.
Ditto ditto	2	1 = 32	Examined additions made in Drawing Office for the Engraving Office.
Index Maps prepared in Drawing Office.	1	1 = 12	Examined for photozincography.
Ditto ditto	3	1 = 24	
Ditto ditto	4	1 = 64	
Special Maps compiled in Drawing Office for various purposes.	8	1 = 4	Examined mostly for photozincography.
	100	1 = 8	
	7	1 = 16	
	2	1 = 32	
	1	1 = 1	
Maps and Charts drawn in the Examining Section.	4	1 = 4	Portions of two atlas sheets and two triangulation charts for Forest and Revenue Surveys.
Engraved proofs of Atlas sheets in various stages.	87	1 = 4	Examined and sent to Engraving Office.
Engraved proofs General and Provincial Maps.	10	1 = 16	Examined additions and corrections made on copper plates from time to time.
Ditto ditto ditto	3	1 = 32	
Ditto ditto ditto	13	1 = 64	
Ditto ditto ditto	2	1 = 80	
Ditto ditto ditto	3	1 = 96	
Ditto ditto ditto	2	1 = 128	
Ditto ditto ditto	2	1 = 256	
Lithographic proofs of Atlas sheets and District Maps transferred from copper plates.	7	1 = 4	Examined corrections in territorial changes and public constructions, such as boundaries, canals, roads, &c.
Lithographic proofs of N. W. Trans-frontier Sheets.	3	1 = 4	

DRAWING OFFICE, CALCUTTA.

SECTION I—*concluded.*

TITLE OF MAP.	Number of Sheets.	Scale. In. Mls.	REMARKS AND PROGRESS.
Lithographic proofs of General and Provincial Maps including Index Charts.	4	1 = 16	Examined and given to Draftsmen.
Ditto ditto ditto	2	1 = 32	
Ditto ditto ditto	2	1 = 64	
Ditto ditto ditto	5	1 = 80	
Ditto ditto ditto	1	1 = 128	
Ditto ditto ditto	2	1 = 256	
Lithographic proofs of Special and Miscellaneous Maps.	1	1 = 5	Examined and given to Draftsmen.
Ditto ditto ditto	1	1 = 16	
Ditto ditto ditto	21	1 = 32	
Ditto ditto ditto	2	1 = 64	
Photographic proofs of Standard sheets, large scale Plans and various other Maps.	20	24 = 1	Examined and given to Draftsmen.
	2	8 = 1	
	9	6 = 1	
	30	4 = 1	
	12	2 = 1	
	194	1 = 1	
	51	1 = 2	
	1	1 = 3	
	42	1 = 4	
	72	1 = 8	
	5	1 = 16	
	2	1 = 24	
	10	1 = 32	
	2	1 = 48	
	2	1 = 64	
	1	1 = 80	
	3	1 = 128	
Projection and Examination of graticule and plotting of points.	20	...	
TOTAL	861	...	

N.B.—In addition to the above, miscellaneous jobs, such as tracings of sketches, charts, supply of geographical data to various officials, calculation of areas, computation of graticule for the plates of the Indian Atlas and testing the same on copper have been performed by the Examining Section, as well as various other minor works too numerous to be mentioned here.
Various other jobs, such as tracing, typing, plotting, have been performed in the Drawing Section.

DRAWING OFFICE, CALCUTTA.

SECTION II.—REVENUE.

Statement showing the work performed and the progress made from 1st October 18 to 30th September 1885.

TITLE OF MAPS.	Number and size of sheets.	Scale.	REMARKS.
		In. Mls.	
PUNJAB.			
District Dera Ismail Khan and Thal of Muzaffargarh.	44 (30′ × 15′)	1 = 1	Publication completed.
District Hissar	14 (30′ × 15′)	1 = 1	Nos. 275, 267, 277 and 278, passed with final press order. Nos. 242 and 243 on 2″ scale for reduction to half completed up to margin. Nos. 241, 244, 256, 257, 258, 259, 260, and 261 being examined and completed.
Do. Do.	29 sections. (15′ × 7′ 30″)	2 = 1	Nos. 241, 242 N. E., 244, 256, 275, 276, 277, and 278 passed with final press order. Nos 243, 257, 258, 259, 260, and 261 examined and sent to press.
Do. Government Cattle Farm .	10	6 = 1	Nos. 258 $\left(\frac{S.E.}{4,7}\ \frac{S.W.}{6,9}\right)$, 259 $\left(\frac{N.W.}{3,6,9}\ \frac{N.E.}{1,4,7}\right)$ passed with final press order.
Do. Civil Station and City of Hissar.	2	12 = 1	Passed with final press order.
District Rawalpindi (Kahuta Forest.)	15 (7′ 30″ × 3′ 45″)	4 = 1	Nos. 160 $\left(\frac{S.E.}{1,3}\right)$ 161 $\left(\frac{N.E.}{4}\ \frac{S.E.}{3,4}\right)$ 162 $\left(\frac{N.E.}{1,2,3,4}\right)$ 185 $\left(\frac{S.W.}{2,3,4}\right)$ 186 $\left(\frac{N.W.}{1,2,3,4}\right)$ examined and sent to press. Publication deferred pending settlement of Forest Boundaries.
District Delhi	6 (30′ × 15′)	1 = 1	Nos. 298, 299, 319, 320, 321, 322, corrected and sent to press for a second edition.
N.-W. PROVINCES.			
Meerut Division . . . Districts Bulandshahr, Aligarh and Etah.	18 (15′ × 7′ 30″)	2 = 1 for reproduction.	Nos. 21, 22, 34, and 51 passed with final press order. Nos. 23, 36, 37, 52, and 53 sent to press. Nos. 35 and 36 are in hand.
Meerut Division . . . Districts Bulandshahr, Aligarh and Etah.	5 (30′ × 15′)	1 = 1	Nos. 21, 22, 34, 35, and 51 final press order given. Sheets Nos. 23, 36, 37, 52, and 53 under examination.
District Hamirpur . . .	2 (30′ × 15′)	1 = 1	Nos. 94 and 110, final press order for second edition.
District Banda, Forest Reserves .	4	4 = 1	Nos. 67, 68, 85, and 86 final press order given.
City of Kasganj, District Etah .	9	20 = 1	Final press order given.
Oudh	22	1 = 1	Final press order given for four sheets. Seven sheets sent to press.
CENTRAL PROVINCES.			
Saugor City	4 sections.	8 = 1	The Map was re-plotted and the topography reduced by pentagraph from 16″ to 8″ for reduction to 6″ = 1 mile. All additions and alterations were made from a map received from the Inspector General of Military Works.
NEPAL BOUNDARY.			
From the tri-junction of Districts *Darjeeling* and *Purneah* to the *River Kosi* and from the *Gunduk* to the *tri-junction* of *Districts* Tarai and Kumaun.	90	4 = 1 2 = 1	Sixty-eight originals, with 22 other sheets, compiled in this office from village plans of Districts Gorakhpur and Basti on the 4″ scale were sent to press for publication. These sheets were specially prepared to suit the requirements of the Foreign Office.
BENGAL.			
District Cuttack . . .	3 (30′ × 15′)	1 = 1	Graticules tested and inked in on the 2″ blue prints of sheets Nos. 225, 226, and 227. Typing of sheet 225 completed; the rest in progress.
Do. Pooree, Killa Khorda .	65	4 = 1	Publication completed.
Do. Midnapore . . .	1	1 = 4	Thana boundaries inserted; ready for press.
Hooghly River Survey . .	9 in 116 sections.	16 = 1	Sent to press for reproduction to scale.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

TITLE OF MAPS.	Number and size of sheets.	Scale.	REMARKS.
		In. Mls.	
Hooghly River Survey . .	Nos. 1-4 in 8 sections. 5-9 1-10 1 & 2	8 = 1 6 = 1 3 = 1 1 = 1	Under examination.
City of Calcutta, Suburbs and Barnagore.	2 sections.	4 = 1	Prepared from materials of different surveys in 6 sheets on the scale of 6″ = 1 mile for reduction by photography to the scale of 4″ = 1 mile to meet the requirements of the Secretary to the Government of Bengal. Passed for publication.
Districts Julpigoree . . .	14	1 = 1	Nos. 293 and 294 with Forest Officer, other proofs being prepared for press.
Burma.			
District Hanthawaddy and Pegu .	20 (15′ × 7′ 30″)	2 = 1	Nos. 90, 91, 92, 97, 99, 105, 106, 107, sent to press. For reproduction to scale. Proofs of Nos. 97, 105 and 106 sent to press for correction. The preliminary edition of No. 92 published.
District Bassein . . .	16 (15′ × 7′ 30″)	2 = 1	Sheets Nos. 103, 104, 112, 113, 121 and 122 passed with final press order.
District Prome	11 (15′ × 7′ 30″)	2 = 1	These are being drawn in this office. The skeletons were received from the Executive's Office and the topographical details were reduced by pentagraph from the 16″ to the 2″, on which scale they are being drawn for reduction. The pentagraphing of these sheets has been finished and the drawing and typing are progressing.
District Tharrawaddy . .	15 (15′ × 7′ 30″)	2 = 1	No. 90 press order given. Nos. 68, 76 and 83 sent to press for reproduction. The preliminary edition of No. 68 published.
Bombay.			
Konkan Survey	4 (15′ × 30′)	1 = 1	Nos. 78 and 83, press order given. Nos. 79 and 82 sent to press for publication.
Do. Do.	54 (7′ 30″ × 3′ 45″)	4 = 1	Nos. 78 (16 sections) 82 (2 sections) and 83 (4 sections) were passed with final press order. Original sheets 79 (8 sections) 80 (16 sections) 82 (8 sections) sent to press for publication.
Deccan Survey	7 (15′ × 30′)	1 = 1	Nos. 51, 58 and 59 press order given. Sheets Nos. 64, 65 were sent to press for reduction to ½ scale.
Provincial Index Map of Bengal .	1	1 = 52	Drawn on scale of 1″ = 32 miles for reduction to 1 = 52 miles sent to press.
Annual Report Index Maps, Index to the Survey Operations in the Punjab, Dehra Dún, Basti, Gorakhpur (North-Western Provinces), Sambalpur (Central Provinces), Ajmere-Merwara (Rajputana), Akyab, Hanthawaddy, Pegu and Shweygyin, Bassein and Henzadá (Burma), Deccan and Konkan (Bombay), Kámrúp (Assam).			Index Maps to the Survey Operations in the Punjab, Ajmere-Merwara and Sambalpur were redrawn; others revised and brought up to date for Annual Report of 1884-85.

DESCRIPTION OF WORK.	REMARKS.
Computations examined.	
District Bassein, Seasons 1879—82.	
„ Tharrawaddy, Seasons 1880—83.	
Districts Hanthawaddy and Pegu, Seasons 1882—84.	

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

DESCRIPTION OF WORK.	REMARKS.
Traverse data, &c., supplied.	
Traverse of Guibee Dera Jagir, District Lárkhána . .	For Superintendent, Sind Revenue Survey.
„ of District Karnál along District Umballa .	For Deputy Superintendent, No. 1 party.
„ of Jumna River Villages, District Umballa (20 pages.)	For Deputy Superintendent, No. 1 party.
„ of District Sylhet along Hill Tipperah .	For Chief Commissioner, Assam.
„ of District Lohardugga along District Mirzapur.	For Magistrate of Mirzapur.
„ of Districts Gya and Shahabad along District Mirzapur.	Ditto ditto.
„ of Districts Moradabad and Tarái along Rámpur Jagir.	For Deputy Superintendent.
„ of District Mirzapur along the boundary between Revenue and Topographical Surveys	Ditto ditto.
„ of the Peint State, Deccan (30 pages) . .	For Superintendent, Revenue Survey and Assessment.
„ of 8 villages of Ganges Deara Survey .	For Collector of Monghyr.
„ of 7 villages of District Shahpur . .	For Settlement Officer.
„ of 50 villages of District Pubna . .	For Collector of Pubna.
„ of 28 villages of District Balasore . .	For Collector of Balasore.
„ of certain W. L. Grants, District Lakhimpur .	For Deputy Commissioner.
Field Book of Guibee Dera Jagir	For Superintendent, Sind Revenue Survey.
„ „ of certain villages of Ganges Deara Survey (59 pages.)	For Collector of Monghyr.
Values and description of Level Bench Marks on sheets 1, 2, 3, Bahawalpur State.	For Colonel Haig.
Statement of triangulated and other stations with their description in District Nimar.	For Deputy Commissioner.
Miscellaneous.	
Computation and plotting of one line of villages of Districts Gorakhpur and Basti along Nepal for preparation of maps of Nepal Boundary.	
Computation and plotting of one line of villages on each bank of the Ganges River, along the whole length of District Rajshahi, east to west, for preparation of a congregated village map.	For Collector of Rajshahi.
Computation and plotting of three groups of villages of District Pubna for preparation of congregated village maps.	For Collector of Pubna.
Preparation of a statement showing the areas of Districts in the Central Provinces according to revised boundaries with explanation of all discrepancies.	For Chief Commissioner.
Computation and plotting of surrounding villages for incorporation with Calcutta map.	For Government, Bengal.
Preparation of areas of Districts Ferozepore and Hissar by addition of villages of portions of Sirsa on the breaking up of the latter district.	
Statement showing season, scale, and character of survey of Districts in Bengal and Assam.	For Government, Bengal.
Statements of the several Provinces and Native States for Religion map.	
Computations, &c., for the graticule projection of Districts Cachar and Jhang.	
Insertion of graticule lines on 1″ original maps of District Jhang in progress.	

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

TITLE OF MAPS.	Scale.	REMARKS.
Tracings.	In. Mls.	
5 Village plans of District Tirhoot .	4=1	For Collector of Durbhunga.
5 Tracings of river Gogra between Districts Basti and Faizabad, showing alluvial villages of latter district.	4=1	For Deputy Superintendent.
1 Tracing of portion of Hazára District.	4=1	For Executive Engineer.
Tracings of sheets Nos. 1 and 6, Karnal Cantonment.	16=1	For Colonel Coddington.
Tracing of portion of Saugor Island showing Dublat Estate.	8=1	For Babu Prosad Das Dutt.
2 Village plans of District Jessore .	4=1	For Collector of Jessore.
Tracings of 2 villages of Ganges Deara Survey, District Nuddea.	4=1	For Deputy Collector of Kooshtea.
Corrected boundary of District Sylhet, sheets 5, 8, 9 and 11.	1=1	For Office Copy.
1 Village plan of District Purneah .	4=1	For Collector.
4 Tracings of boundary between Districts Karnál and Umballa.	4=1	For Colonel Coddington.
2 Village plans of District Bhágalpur.	4=1	For Commissioner, Sonthal Parganas.
1 Tracing of Pargana Jamooee, District Bhágalpur.	1=1	For Commissioner.
6 Village plans of District Azamgarh	4=1	For Major Sandeman.
1 Village plan of District Pubna .	4=1	For Deputy Collector of Kooshtea.
1 Tracing of 3 villages of District Pubna.	4=1	Ditto ditto.
17 Tracings of Nepal boundary along Districts Basti, Gorakhpur and Chumparun.	4=1	For Colonel Tanner.
6 Tracings of boundary between Districts Sylhet and Independent Tipperah.	4=1	For Chief Commissioner, Assam.
291 Village plans of Parganas Sadda and Pussaye of District Bhágalpur now transferred to Sonthal Parganas.	4=1	For Deputy Commissioner, Sonthal Parganas.
2 Traces of Sehanwan, District Monghyr.	4 & 2=1	For Collector of Patna.
2 Traces of boundary between Districts Lohardugga and Mirzapur.	4=1	For Deputy Commissioner, Lohardugga.
1 Trace of 6 villages of District Mymensingh.	4=1	For Collector of Pubna.
Trace of portion of Pubna along Ganges River showing villages (Deara Survey).	1=1	For Deputy Collector of Kooshtea.
7 Traces of portion of Pargana Fatehpur Sikri, District Agra.	4=1	For Collector.
2 Village plans of District Bijnor .	4=1	For Additional Judge of Moradabad.
1 Village plan of Pargana Ghiáspur, District Patna.	2=1	For Collector.
36 Village plans of Pargana Plassey, transferred from District Nuddea to Moorshedabad.	4=1	For Collector of Moorshedabad.
19 Village plans of District Manbhoom.	4=1	For Deputy Commissioner.
1 Trace of Tundi Khas and Hills .	4=1	Ditto ditto.
1 Trace of Grant No. 20, District Lakhimpur.	4=1	Ditto ditto.
28 Traces of villages of District Balasore.	4=1	For Collector of Balasore.

DRAWING OFFICE, CALCUTTA.

SECTION II—*concluded.*

TITLE OF MAPS.	Scale. In. Ms.	REMARKS.
447 Village plans of Pargana Bisára Chakla Nyi, District Mozufferpore.	4=1	For Superintendent of Survey, Mozufferpore.
1 Trace of portion of sheets 5, 6 and 9, Ganges Doara Survey.	4=1	For Deputy Surveyor-General.
1 Trace showing villages along the boundary between Districts Umballa and Saháranpur.	2=1	For the Board of Revenue, North-Western Provinces.
1 Trace showing villages along the boundary between Districts Umballa and Saháranpur.	2=1	For Government, Punjab.
1 Congregated trace of 4 villages, District Pubna.	1=1	For Collector.
Map coloring.		
Maps on various scales . . .	69	For Surveyor-General's Office.
Ditto ditto . . .	69	
Ditto ditto . . .	680	For India Office.
Ditto ditto . . .	884	For District officials.

DRAWING OFFICE, CALCUTTA.

State of publication of Cadastral Maps on the 30th September 1885.

NUMBER OF SHEETS.

Districts.	Maps Prepared.			Published.				Remarks.
	Up to 30th September 1884.	Added during past 12 months.	Total up to 30th September 1885.	Up to 30th September 1884.	By Surveyor-General's Office, during past 12 months.	Total to 30th September 1885.	Remaining to be published.	
N. W. Provinces.								
Agra	2,924	...	2,924	2,924	...	2,924	...	
Azamgarh	930	...	930	930	...	930	...	
Ballia	1,284(a)	...	1,284	1,243	41	1,284	...	(a) Figures of previous return have been changed to agree with final results.
Banda	3,317	...	3,317	3,317	...	3,317	...	
Basti	...	1,402	1,402	...	...	...	1,402	
Benares	644	800	1,444(b)	586	428	1,014	430	
Bijnor	31	...	31	31	...	31	...	
Dehra Dún	...	726	726(b)	...	188	188	538	
Ghazipur	3,050	...	3,050	3,050	...	3,050	...	(b) These figures are liable to alteration until publication has been completed.
Gorakhpur	...	1,795	1,795	...	...	...	1,795	
Hamirpur	2,926	...	2,926	2,926	...	2,926	...	
Jaunpur	3,434	...	3,434	3,434	...	3,434	...	
Moradabad and Tarai	4,023	...	4,023	4,023	...	4,023	...	
Mutra	1,658(a)	...	1,658	1,658	...	1,658	...	
Mirzapur	3,653	...	3,653(b)	3,434	204	3,638	20	
Tarai	94	252	346	94	252	346	...	
Total	28,073	4,975	33,048	27,750	1,113	28,863	4,185	
British Burma.								
Akyab	...	946	946(b)	...	107	107	839	
Bassein	2,764 (c)	313	3,077(b)	2,445	367	2,813	264	(c) Includes 48 sheets of Bassein Municipality surveyed on the scale of 64 inches to the mile.
Hanthawaddy and Pegu	4,585	16	4,601	3,782	819	4,601	...	
Henzada	498	1,205	1,698(b)	101	342	443	255	
Prome	736	121(d)	857(b)	246	511	757	50	
Tharrawaddy	1,303	...	1,303	1,197	206	1,363	...	
Total	9,631	2,601	12,232	7,772	2,452	10,224	2,008	(d) Includes 10 sheets of the town of Prome, surveyed on the scale of 64 inches to the mile.
Bengal.								
Patna and Gya	3,054	...	3,054	3,054	...	3,054	...	
Shahabad	4,924	...	4,924	4,924	...	4,924	...	
Pooree (Khorda Estate)	4,566 (a)	...	4,566(b)	3,276	1,214	4,490	76	
Total	12,544	...	12,544	11,254	1,214	12,468	76	
Assam.								
Kámrúp	...	1,037	1,037(b)	...	383	383	654	
Sylhet	61	...	61(b)	16	...	16	45	
Total	61	1,037	1,098	16	383	399	699	
Central Provinces.								
Raipur	...	43	43(b)	...	43	43	...	
Total	...	43	43	...	43	43	...	
Grand Total, N. W. Provinces, Burma, Bengal, Assam and Central Provinces	50,309	8,656	58,965	46,792	5,205	51,997	6,968	

Abstract of work performed during past year.

Provinces.	Number of Sheets.				Remarks.
	Examined and rendered suitable for photo-zincography.	Traced and examined for zincography.	Proof copies examined previous to press order.	Coloured and subsequently examined.	
N. W. Provinces	1,093	294	1,127	1,113	Scale 16 inches=1 mile,
British Burma	1,075	537	2,476	2,461	Scale 16 inches=1 mile,
Bengal	480	746	1,223	1,214	„ 32 ditto.
Assam	216	107	409	383	„ 16 ditto.
Central Provinces	43	...	43	43	„ 16 ditto.
Total	3,50	1,744	5,278	5,205	

PROGRESS REPORT OF THE ENGRAVING OFFICE, CALCUTTA, FROM 1ST OCTOBER 1884 TO 30TH SEPTEMBER 1885.

TITLE OF MAP.	Outline.	Writing.	Hills, Sand-Hills and Jungle.	Remarks showing progress.
General Maps, &c.	Sq. in.	Letters cut.	Sq. in.	
India in six sheets, scale 1 inch = 32 miles—				
Sheet I . . .	...	...	117 H.	Corrections and additions to outline and writing, large portion of Afghanistan formerly engraved was cleared off, being incorrect.
Skeleton Map of India, in four sheets, scale 1 inch = 64 miles	7	7,599	...	Additional outline, writing, railways, and new scale.
India, in two sheets, scale 1 inch = 80 miles . . .	...	2,018	...	Corrections and additions.
India, scale 1 inch = 96 miles .	...	2,830	...	Ditto ditto to outline and writing.
India, "Skeleton," scale 1 inch = 128 miles . . .	...	336	...	Corrections and additions, and new scale.
India, scale 1 inch = 256 miles.	...	240	...	Corrections and additions to railways.
India, "Meteorological" . .	...	188	...	Corrections and additions.
Assam, scale 1 inch = 16 miles	...	241	9 H.	Slight additions, plate.
Bengal, in two sheets, scale 1 inch = 16 miles . . .	...	...	32 H.	Hills just commenced.
Berar, scale 1 inch = 8 miles .	10	1,436	72 H.	Heavy corrections and additions to outline and writing in progress; plate well advanced.
Central India Agency in two sheets, scale 1 inch = 16 miles	...	3,554	...	Additional outline and writing.
Rajputana in two sheets, scale 1 inch = 16 miles . . .	...	2,185	13 H.	Ditto ditto, writing and hills.
Traverse Indicator . . .	...	4,318	...	Completed.
Index chart to the Great Trigonometrical Survey . . .	...	...	...	Corrections and additions to outline.
Paper graticule plates . .	...	984	...	Slight additions to six plates.
Scale of Gunter's chains 16 inches = 1 mile	...	99	...	Completed.
Two diagonal scales 16 inches = 1 mile and 24 inches = 1 mile	...	542	...	Completed.
Bigah comb scale 24 inches = 1 mile	...	511	...	Completed.
Scale for projecting, 16 inches = 1 mile maps . . .	...	...	...	In progress.
The Viceroy's appointment plate, Lord Dufferin's crest .	...	650	...	In progress.
Seal for S. I. Department .	...	450	...	Completed.
Map headings . . .	...	1,050	...	Additions made to six plates.
Imprint plates . . .	...	192	...	Additions made to six plates.
Punjab Irrigation plate . .	...	152	...	Completed.
Persian seal for Cadastral maps .	...	700	...	Completed.
Theodolite, limbs . . .	...	4,788	...	Twenty scales figured for M. I. O.
Two tints for registering colour printing	...	...	...	Completed.
Calcutta International Exhibition Medals . .	...	4,800	...	Twelve engraved.
Heliogravure plates by Colonel J. Waterhouse . . .	...	9,662	...	Titles cut to twenty-six plates and one or two touched up.
Miscellaneous . . .	...	5,017	...	Letters cut.
TOTAL .	17	54,841	241 H.	

ENGRAVING OFFICE, CALCUTTA.

Title of Maps.	Outline.	Writing.	Hills, Sand-Hills and Jungle.	Remarks showing progress.
Indian Atlas Sheets (new) completed and published.	Sq. In.	Letters cut.	Sq. In.	
13 S.E.	...	510	57 H., 120 J.	Completed.
18 N.E.	...	1,416	...	Imprint corrected, slight additions.
19 N.E.	...	1,167	45 S.H.	
20 N.E.	...	1,034	20 H. 29 S. H.	
35 N.W.	...	213	36 H.	Completed up to margin.
37 S.E.	...	3,134	69 H.	
48 S.E.	...	638	25 H.	
69 S.E.	...	139	10 H.	
Total	...	8,241	217 H. 74 S.H. 120 J.	
Indian Atlas Sheets (new) in progress.				
4 S.E.	...	2,019	...	Outside figures cut.
6 N.E.	50	2,080	...	Projected; border and scale completed; writing in progress.
6 S.E.	19	1,981	...	
12 N.E.	85	...	...	Reprojected; border cut, and portion of outline in progress.
12 S.W.	4	4,220	...	Additional outline, writing, and waterlining completed.
14 S.E.	93	1,018	...	Outline as far as survey completed; writing in progress.
15 N.W.	209	...	...	Outline well advanced; sandy bed of rivers dotted.
15 S.W.	231	5,501	...	Scale cut; outline finished up to margin, writing about $\frac{3}{4}$ths done.
16 S.W.	6	...	...	Outline in progress.
18 S.E.	...	2,493	63 S. H.	Slight corrections to outline completed; sand-hills in progress.
19 S.E.	...	2,618	...	Sand-hills in progress.
20 S.E.	55	1,544	11 H.	Additional outline and writing completed; hills in progress.
1 S.E.	19	1,152	...	Outline and writing completed as far as drawing.
22 N.W.	4	191	...	Corrections and additions to outline and writing.
23 S.E.	32	2,873	...	Writing in progress.
35 S.W.	2	1,945	36 H.	Hills in progress.
36 N.W.	16	...	...	Additional outline completed.
37 S.W.	32	2,565	...	Writing in progress.
38 N.E.	98	...	...	Outline as far as drawing completed; writing in progress.
38 N.W.	...	722	102 H.	Plate completed as far as drawing.
38 S.E.	...	4,182	...	Outline and writing nearly finished.
38 S.W.	...	9,674	22 H.	Hills in progress.
39 N.W.	...	9,620	...	Writing about $\frac{3}{4}$ths done.
49 S.W.	...	20,338	...	Writing finished; hills in progress.
50 N.E.	6	6,588	...	Additional outline and writing completed; hills in progress.
40 S.E.	18	825	...	Writing in progress.
42 S.E.	108	...	...	Outline finished as far as drawing; writing in progress.
43 N.E.	117	...	...	Border cut; outline finished as far as drawing.
48 N.E.	...	9,765	...	Slight corrections to outline completed; writing in progress.
48 S.W.	140	...	...	Reprojected; border cut; outline in progress.
49 N.E.	10	14,233	...	Slight corrections to outline completed; writing in progress.
49 N.W.	112	3,605	...	Reprojected; writing in progress.
49 S.E.	...	27,415	...	Outline and writing finished; awaiting hill drawing.
49 S.W.	...	15,875	...	Writing in progress.
50 N.E.	24	...	...	Outline in progress.
Carried over	1,490	1,55,042	171 H. 63 S.H.	

N.B.—A Full Sheet of the Indian Atlas contains 927·2 square inches; a Quarter Sheet 231·8 square inches.

ENGRAVING OFFICE, CALCUTTA.

Title of Maps.	Outline.	Writing.	Hills, Sand-Hills and Jungle.	Remarks showing progress.
Indian Atlas Sheets (new) in progress—continued.	Sq. In.	Letters cut.	Sq. In.	
Brought forward .	1,490	1,55,042	171 H. 63 S.H.	
50 S.E.	...	5,557	...	Slight corrections to outline completed; large portion cleaned off.
60 N.E.	194	...	...	Border cut; outline well advanced, in progress.
60 N.W.	228	258	...	Border, outside figures, and outline as far as drawing completed.
60 S.E.	103	...	...	Border and scale completed; outline in progress.
61 S.E.	...	3,318	...	Outline and writing finished; awaiting hill drawing.
67 N.W.	105	2,197	...	Additional outline cut; writing well advanced.
67 S.W.	119	1,224	...	Additional outline cut; writing in progress.
75 S.E.	...	196	...	Outside figures cut.
76 N.W.	...	205	...	Additions done.
76 S.W.	...	6,132	...	Writing nearly finished.
77 S.E.	22	732	...	Outline to portion of new work, and waterlining completed; writing in progress.
78 N.E.	...	7,615	...	Well advanced; writing nearly finished.
78 S.W.	180	...	...	Outline nearly finished as far as drawing.
79 N.W.	...	7,663	...	Slight corrections to outline; writing nearly finished as far as drawing.
79 S.W.	...	23,955	...	Writing finished as far as drawing; 454 lakes shaded.
88 S.W.	...	7,853	...	Writing in progress.
114 N.E.	...	6,225	...	
114 S.E.	...	15,487	...	Writing well advanced.
114 S.W.	100	...	...	Outline well advanced.
115 N.E.	...	4,521	...	Slight corrections to outline; sand banks, scale, outside figures, and writing, completed as far as drawing.
125 S.E.	228	60	...	Border cut; outline nearly finished.
131 N.E.	...	639	57 H.	Slight corrections to outline and writing; plate completed as far as drawing.
131 S.E.	...	2,609	39 H.	Plate completed as far as drawing.
Total .	2,769	268,488	267 H. 63 S.H.	
Additions and corrections to the Indian Atlas Sheets.				
8 N.E.	...	96	...	Slight corrections completed.
31 N.W.	...	146	...	
31 S.E.	12	...	...	Heavy corrections in progress.
32 N.E.	28	111	...	
32 S.E.	2	12	...	
34 N.W.	...	...	...	Slight corrections to outline; writing and hills completed.
34 S.E.	...	...	...	
34 S.W.	...	40	...	Slight corrections completed.
35 N.E.	...	...	...	Corrections to outline and writing completed.
35 S.E.	...	330	...	Corrections and additions completed.
36 N.E.	...	...	...	Slight corrections to hills completed.
51 N.E.	...	200	...	Corrections finished.
51 S.E.	...	444	...	Corrections and additions to boundaries and outline completed.
52 N.E.	...	433	...	
69 N.W.	...	395	...	Corrections and additions completed.
69 S.W.	4	81	...	
71 S.E.	...	242	...	
76 S.E.	...	170	...	
90 S.E.	...	543	...	
Carried over .	46	3,242	...	

ENGRAVING OFFICE, CALCUTTA

Title of Map.	Outline.	Writing.	Hills, Sand-Hills and Jungle.	Remarks showing progress.
Additions and corrections to the Indian Atlas Sheets.—contd.	Sq. In.	Letters cut.	Sq. In.	
Brought forward	46	3,242	...	
91 N.E.	6	554	...	Corrections and additions to district names and boundaries completed.
91 N.W.	...	324	...	Corrections finished.
91 S.E.	...	1,159	...	Corrections and additions to district names and boundaries both on plate and matrix completed.
93 S.E.	...	302	...	Corrections and additions to outline and writing completed.
105 S.E.	...	...	...	Slight corrections completed.
124 S.E.	2	264	...	Corrections and additions to outline and writing completed.
125 N.E.	...	253	...	Additions and corrections to district names completed.
125 N.W.	...	958	...	
125 S.W.	...	412	...	
126 N.E.	...	120	...	Slight corrections completed.
126 N.W.	...	612	...	Additional boundaries and district names added.
Total	54	8,200	...	
Repairs and corrections to old plates of the Indian Atlas.				
25	...	...	8 H.	Hills repaired.
28	4	6,992	67 H.	Heavy additions, outline, and writing to new portion completed, hills in progress.
30	...	...	...	Slight corrections to writing completed.
46	...	...	200 H.	Hills being repaired, in progress.
47	...	...	130 H.	
107	...	...	46 H.	Hills repaired.
115	...	...	...	Slight corrections completed.
Total	4	6,992	461 H.	
New plates projected, borders cut, &c.				
4 N.E.	...	1,501	...	Outside figures completed.
4 N.W.	...	1,311	...	Border, scale, and outside figure completed.
24 S.E.	...	...	...	Outside figures completed.
39 S.E.	...	389	...	
40 S.W.	...	...	...	New scale cut.
59 S.E.	...	61	...	Outside figures cut.
Total	...	3,261	...	

Abstract of work completed and in progress.

Engraving.

	Plates.
Atlas sheets completed	8
Ditto in progress in various stages	58
General maps, plans, &c.	102
Repairs, corrections, and additions	37
Projections engraved, borders cut, &c.	6
Total	211

Copper-plate printing.

Impressions taken	16,738
Proofs pulled	524
Transfers pulled	393
Total	17,655

Steel-facing.

	Plates.
Double elephant plates, steel-faced	4
Ditto ditto steel-removed	15
Quarter plates, steel-faced	20
Ditto steel-removed	33
Miscellaneous plates, steel-faced	54
Ditto ditto steel-removed	15
Total	141

Square inches of hill-etching	1,323
Ditto of jungle etched	120
Ditto of outline	2,844
Numbers of letters engraved	340,023

Extract from the Report of LIEUTENANT-COLONEL J. WATERHOUSE, S.C., *Assistant Surveyor-General, in charge Photographic Office;—season 1884-85.*

OUT-TURN.—The out-turn of the year under report, both Normal and Cadastral, shows a very large increase over the previous year, and there has been great activity in all sections of the Office, as will be seen from the subjoined statements.

ORIGINAL SUBJECTS.—The number of subjects received for reproduction in the various sections of the Normal Establishment was no less than 1,701, the departmental and extra-departmental being about equally divided. They consisted of maps, plans and drawings of the usual character, also negatives sent for printing by certain departments and officers. The number of cadastral sheets received was 5,156, of which 3,490 were original sheets and 1,666 tracings for zincography.

NEGATIVE SECTION.—In this section two cameras have been kept almost constantly at work and many of the negatives have been taken in the 32 × 24 camera; 2,511 negatives were taken, aggregating 5,529 square feet, and besides these 62 reversed negatives and transparencies, for use in the photo-collotype or heliogravure processes, were prepared by Mr. Haward or Mr. Turner. The number of negatives taken of cadastral sheets was 3,490, aggregating 18,607 square feet (sufficient to cover a wall over 1,000 yards long and 6 feet high).

The processes in the negative section have remained the same, but since my return from leave I have introduced a method of intensifying which I saw in use at the Ordnance Survey Office, Southampton, which is a very great improvement over the methods hitherto in use though somewhat more expensive.

After a first intensification, followed by fixing and washing as usual, the negative is immersed in a bath containing—

Bromide of potassium	3 parts.
Sulphate of copper	10 „
Water	100 „

This at once turns the plate a whitish yellow colour, and when the colour is even all over it is taken out, well washed and then flowed over with a solution of nitrate of silver at 2½ per cent., which turns the film a dense black. The plate is then washed, dried, and varnished.

The above formula varies slightly from the one used at Southampton, which is—

Bromide of potassium	3 parts.
Sulphate of copper	5 „
Water	128 „

followed by treatment with a 10 per cent. solution of nitrate of silver.

The cost of the new intensifier has been calculated to be about half as much again as the ordinary method with bichloride of mercury followed by hyposulphite of soda and ammonia, but the negative films are not rendered so tender and keep better without spoiling. By carefully saving the washing waters containing nitrate of silver, it is probable that the final expense would be little increased, while the results are certainly better.

PHOTO-TRANSFER SECTION.—2,404 photo-transfer prints of ordinary departmental and extra-departmental work have been printed, and 3,496 of cadastral sheets. The processes in this section have remained without change.

ZINC PRINTING SECTION.—The total number of zinc plates printed off by the Normal Establishment was 926, the number of pulls being 121,909 and of copies 159,370. It is noticeable that very nearly three times as many plates of standard sheets of the Revenue and Topographical Surveys were printed off as were printed last year, and the number of copies is about twice as many.

Mr. B. Mackenzie has introduced a very satisfactory method of preparing tracing prints in place of the blue prints hitherto used. Thin bank post paper is carefully pasted over a copy of the map to be traced and run through the press. The details show quite clearly enough under the paper to form a very good guide for the draughtsman, while they do not reproduce when photographed. The prints being free from grease are much pleasanter to draw upon than the ordinary zincographed blue prints, and the ink does not turn yellowish as it does in the latter.

The Cadastral Zinc Printing Section also shows a large out-turn, amounting to 170,906 copies of 5,160 sheets or 37,715 more than last year.

SILVER PRINTING SECTION.—There has been quite an unusually large amount of work in this section during the year, chiefly in printing copies of the photographs of Indian Art-work taken during the Calcutta Exhibition, also in preparation for the Indo-Colonial Exhibition and copies of the sketches taken by Captain E. L. Durand, with the Afghan Boundary Commission. The total number of prints done was 3,906, 3,582 being extra-departmental and 324 departmental.

HELIOGRAVURE SECTION.—There has been very considerable progress in this section. Mr. A. W. Turner, who had been attached to the office as special assistant, left at the expiration of his term of service on the 1st January 1885, and I then worked myself as opportunity permitted at the various processes and prepared several plates. Mr. Turner rejoined the office as a volunteer from the 1st April, and was subsequently appointed permanently as photo-engraver from that date. He at once took the work in hand, and the section has now become fairly organised for regular work.

Mr. Turner has brought the photo-etching process described in last year's report to considerable perfection during the year. The details of the process are practically the same as then described. A much finer and closer grain is used, which gives better definition and more detail in the lights than was obtained previously. As the cold weather advanced it was noticed that there was a decrease in the power of the gelatine image to resist the perchloride of iron, due apparently to the dryness of the atmosphere, a gelatine film containing a small amount of moisture forming a better resist than one absolutely dry. This difficulty has been partly overcome by adding a small quantity of chloride of calcium to the spirits used for drying off the image. The Autotype Company have prepared a special tissue for use in this process which has been found to answer very well indeed; it contains more gelatine and less colouring matter than the ordinary tissues, and consequently the action of the light penetrates more deeply into the film and gives a stronger image, being more transparent, also, it allows greater facility for watching the action of the perchloride of iron during the etching. With this new tissue it is unnecessary to intensify the transparencies.

A great part is played in the process by judicious re-biting after the first biting. Mr. Turner has found the use of a very weak solution of perchloride of iron advantageous for this purpose, as there is less danger of biting through the resist and the image can be rolled up with a very much thinner layer of ink; the more delicate parts of the plate can thus be re-bitten without injuring the high lights. The perchloride may be used as weak as 1 per cent.

A good ink for rolling up the image previous to re-biting is composed of equal parts of hard retransfer ink and black moulding wax made of—

Spermaceti	200 parts.
Stearine	100 „
White wax	80 „
Asphalt	40 „

For reducing the strength of transparencies intensified with permanganate of potash a solation of gum water and citric acid is useful; it can be applied either locally or over the whole plate.

This photo-etching method has been very successfully applied during the year to the reproduction of brush-shaded maps, though as yet only in an experimental way. A reproduction of a sheet of a map of the Red Sea, received from the India Office, leaves little to be desired as a faithful reproduction of very delicate hill shading. Trials have also been made with sheets of the Atlas of India with very promising results, which, it is hoped, will soon take a practical form.

The photo-electrotype process has also been worked during the year with fair success; the only alteration in the method of working is in the use of a new patent tissue specially prepared by the Autotype Company for this purpose. It contains a quantity of plumbago in place of the colouring matter used in the ordinary tissue. The granularity of the plumbago produces an image in a graduated grain varying with the depth of shadow forming the picture, thus obviating the necessity of graining the relief with stearined emery as previously done. The plates produced by the new tissue require somewhat less touching up than those done by the former method, the lights being as a rule clearer. They do not, however, give such delicate half-tone as the emery process, and the grain being finer does not stand wear so well. In depositing the copper in the battery there is also a liability to breaking up the deep shadows in consequence of the conducting power of the plumbago acting through the substance of the gelatine film instead of only on its surface. The new tissue was found to work very well during the summer months.

Mr. Turner also worked at various processes of producing photo-typographic blocks for printing with type, and during the year several successful blocks were produced of line subjects and some promising results in half tone.

The following as an outline of the method by which the best results were obtained.

A sheet of patent plate-glass is coated thickly with a solution of—

Heinrich's Gelatine	1 ounce,
Water	8 ounces.

When dry the coating is sensitised in a solution of bichromate of potash at 5 per cent. and again dried. The plate is then exposed under an ordinary negative of a line subject, until the action of the light penetrates the gelatine film through to the glass support. This generally requires an exposure of about 10 minutes in the sun. In case of under-exposure, the plate must be placed face downwards on a black cloth and the back exposed to the sun until the action of the light meets that of the previous exposure under the negative.

The plate is then allowed to soak in cold water until sufficient relief is obtained. This will take two or three hours, or, in some cases, the plate may be left to soak all night. The surface moisture is then removed with a soft cloth and a cast of the relief is taken in the moulding wax previously mentioned. As soon as cool the wax cast can readily be removed.

In this cast the lines are raised as in the finished block. A conducting surface is given to it by brushing with plumbago in the ordinary way, and it is then electrotyped, only sufficient copper being deposited to give it sufficient strength for handling. Two days in the simple battery will generally be sufficient. The electrotype is easily separated from the wax, and forms a thin copper-plate with the lines sunk and can be used as a matrix for producing any number of blocks by subsequent electrotyping.

Unless, however, the subject be one with very close lines, there would not be sufficient depth for clean printing, and therefore all the open part of the subject must be built up with wax on the matrix to give the necessary depth on the finished block. This is done by means of a hot pen dipped in melted wax or moulding composition. The electrotype is then taken and afterwards backed with type metal and is ready for printing.

The blocks for half-tone subjects are produced by a somewhat similar method. The sensitised gelatine film is first exposed under a grained glass or a piece of wire gauze (the latter proving most successful) for a few minutes and afterwards under an ordinary half-tone negative. It is afterwards treated in precisely the same way as for line work. The method promised very good results, but will require a good deal of working out to bring into general practice, and in any case would only be suitable for small work.

The process has been found useful in making blocks of the vernacular titles used on the cadastral maps, and these save a great deal of time in writing by hand. Some blocks of the new departmental seal were produced in various sizes from a drawing. To prove its applicability to map work a small map of District Darjeeling on the scale of 8 miles=1 inch was reproduced with very fair success.

Electrotyping is now becoming one of the recognised sections of the work of the office, both in its use for heliogravure and block processes, and also for other purposes, such as duplicating the engraved sheets of the Atlas of India. During the year an electro matrix and duplicate printing plate were taken off one of the quarter Atlas sheets on which corrections were required, also some electrotypes from wax casts of a 100 gold mohur piece belonging to the Maharajah Scindia. For all these purposes the Vienna simple battery is found to answer very perfectly, is cheap and simple to work, and very regular in action.

I have not been able to work much myself at these processes, except during the time Mr. Turner was away. As the rooms Mr. Turner formerly worked in were wanted for other purposes, I had to transfer the heliogravure section to No. 2, Wood Street, where there is plenty of room for it, but the separation of this work from under my own eye is certainly inconvenient and prevents my taking such a personal share in the work as I otherwise might do. I have, however, been able to direct Mr. Turner, who has shown great zeal and aptitude for this work and deserves commendation for the progress made.

The total number of heliogravure plates turned out during the year was 79 (27 photo-electrotypes and 52 photo-etchings) chiefly of the series of illustrations of Indian Art-work.

Photo-Collotype Section.—The work has gone on fairly steadily throughout the year in this section, though considerable difficulties were experienced in the early part; 2,000 copies each of two plates of a carved ivory jewel casket were printed and supplied to Mr. W. Griggs for publication in the Indian Art Journal; 530 copies each of two plates of views of Naini Tal and Bhim Tal were supplied to the Gazetteer, North-Western Provinces; 750 copies each of two plates of gold coins, and one plate of a Hindu temple taken from a photograph, were printed for the Asiatic Society; also 2,012 copies each of two plates of the commemorations and award medals of the Calcutta International Exhibition. A few plates of Indian Art-work were also printed by way of experiment.

Mr. Haward also continued experiments in transferring strongly-grained collotype prints to zinc and obtained some fair results, though the method requires yet more working out when leisure permits.

At the commencement of the period under report I went on tour for seven weeks, visiting the Revenue and Topographical Parties recessing at Naini Tal and Mussooree with the object of inspecting the fair maps and conferring with executive officers regarding their drawing and preparation for reproduction. From the latter place I proceeded to Simla to confer with the Surveyor-General and the officials concerned regarding the Military Map of India and other matters. Under the orders of Government I revisited Dehra on my way back, as a member of a Committee on the working of the large photo-heliograph, and returned to Calcutta on the 19th November. I believe that the tour was of advantage in enabling me to point out to executive officers the requirements of photo-zincography.

As my health had been unsatisfactory for some time past, I took privilege leave to Europe for three months from the 18th July, and took advantage of my leave to visit the Military Cartographic Institute at Brussels, where I was very well received by Colonel Hennequin and other officers of the Institute and shown all that was of interest. Colonel Hennequin also very kindly gave me a list of the most noteworthy objects of cartographic or photographic interest in the Antwerp Exhibition, and I was thus enabled in a flying visit to see all that was worth seeing of that kind. Among the objects which most struck my attention was an instrument called "photo-topographia" exhibited by the Military Geographical Institute at Florence. It appeared to be a combination of theodolite and camera, but I had not the opportunity of examining its construction. Some good specimens of maps in heliogravure in line were also exhibited by the Institute, but no half-tone work; also some zinc plates in slight relief, but apparently inked in the same way as ordinary photo-zincographs. The results were not much better than the latter, but the plates may possibly stand printing better.

In the French section heliogravure was largely represented, but chiefly by the art publishers.

While in England I paid a visit to the Ordnance Survey Office, Southampton. Colonel Stotherd, R.E., the Director of the Ordnance Survey, very kindly allowed me to see the offices, and I was much interested in the new processes and methods adopted for photozincographing the six-inch maps of the Ordnance Surveys.

These are reduced direct from the 25-inch sheets, and in order to do away with the corrections on zinc which we find so troublesome here, the principle has been adopted of having the maps as complete as possible with headings and foot-notes, &c., and making any corrections necessary on the negatives. As soon as the negative is taken a print in platinum is taken and sent in for examination. The necessary corrections are noted on it and are carried out on the negative, being cut in with a point by trained draughtsmen or engravers, names and details not required are stopped out with black varnish, faint lines are cut in, even hill work is engraved in with points and ornament worked in with roulettes. The negative is, in fact, worked upon until it is perfect in every respect and then the photo-transfer print is taken and transferred to zinc. The results of this system are admirable and the maps are almost as delicate as fine engravings. It may be mentioned that the originals are all drawn and typed in an uniform exaggerated style which has been carefully worked out so as to produce exactly the required result when reduced, and founts of type resembling engraved stump letters have been specially cut for use on these maps.

The system of intensifying the negatives for this work has already been noticed in paragraphs 6 and 7.

I should be glad to see some similar system introduced here, but the conditions under which we work are so different to those obtaining at the Ordnance Survey Office and the pressure of work is so great from inside and outside the Department, that it would be very difficult. I have, however, paid more attention to the cutting in of faulty details on the negatives, and this is a great saving of after-work on the zinc plates.

I paid several visits to the Inventions Exhibition, and saw a good deal that was of special interest in connection with our work in the way of recent improvements in photographic apparatus, negative paper processes, small motors for printing machines, litho-plates, a new substitute for lithographic stones prepared by carefully coating finely grained thin zinc plates with a solution of carbonate of lime in carbonic acid, or some similar preparation, whereby a thin film of insoluble carbonate of lime is left on the plate, conferring upon it many of the good properties of lithographic stone without the disadvantage of weight. I brought out a few of these plates to try, but have not yet had an opportunity of doing so, owing to the pressure of work in the Lithographic and Photographic Offices. I saw them in use in machines in Messrs. Layton Brothers of Farringdon Street, and some excellent specimens of work done by them.

The drawback to their use, in this country especially, is that the coating will not last for more than one or at most two jobs, and must then be renewed by the manufacturers. For work of a finished nature not requiring touching up and of which a large number of copies are required, these plates would probably be found useful, and are so cheap that their cost might almost be disregarded in the cost of some thousands of copies. I hope to have an early opportunity of trying the plates upon a suitable subject and reporting further upon them.

I was interested in small motors, chiefly with reference to the wants of the Lithographic Office, for a small engine that could drive the new lithographic and type printing machines without requiring regular installation of boilers, &c. I saw several, but the one most recommended was the Davey Domestic Motor or Safety Engine, manufactured by Messrs. Hathorn Davey and Co. of Leeds. I am indebted to Captain Sankey, R.E., of the Ordnance Survey Office, who kindly accompanied me on a visit to the Exhibition, for a great deal of practical information on this subject, as well as printing machines and dynamos in connection with electrotyping.

I also visited the Autotype Company's works and saw their arrangements for electrotyping heliogravure plates by means of a dynamo machine. I also visited other works, &c., in London and Paris, but my time was so short that I had not time to see and do so much as I could have wished.

A good deal of my spare time was again occupied in preparing new plans for the Lithographic and Photographic Offices so as to bring them within the sanctioned estimates. I believe I have now succeeded in making a very good arrangement for the two offices, and sincerely trust that it may be possible to make an early commencement of these buildings which have been so long under consideration. With the new extensions of the work of the office serious inconvenience is caused by the scattering of the sections between the two houses.

PHOTOGRAPHIC OFFICE, CALCUTTA.

Statement showing Expenditure (Dr.) and Value of Work done (Cr.) during the Survey year from 1st October 1884 to 30th September 1885.

Dr. **Cr.**

Normal Establishment.	Rs.	a.	p.	Rs.	a.	p.		Rs.	a.	p.	Rs.	a.	p.
Superintendent's salary	11,691	6	4				Departmental maps and plans	43,276	13	7			
Assistant Superintendent's salary	1,161	4	9				Miscellaneous maps and plans, extra departmental	30,324	8	4			
Establishment	27,366	12	6								73,541	5	11
Office rent and taxes	4,402	0	6				Cadastral maps North-Western Provinces	36,446	12	0			
Contingencies	1,903	14	3				Cadastral maps, Central Provinces	128	0	0			
				46,530	6	4	Ditto British Burma	31,916	12	0			
Cadastral Establishment.							Ditto Assam	6,236	4	0			
							Ditto Bengal	36,767	8	0			
Establishment	28,831	0	8								74,523	4	0
Office rent and taxes	3,295	8	6				Old tin and packing cases sent to Mathematical Instrument Office	125	7	0			
Contingencies	5,612	13	7				Articles and stores supplied to other Branches	312	10	6			
				37,839	5	9					438	1	6
Chemicals and stores received from England	11,144	2	2										
Paper received from England	4,645	1	0										
				15,789	3	7	Sale of unserviceable articles	233	11	6	233	11	6
Stores received from Mathematical Instrument Office	103	14	0										
Cost of repairs of articles at Mathematical Instrument Office	282	15	0										
				386	13	0							
Paper received from the Litho. Office	5,832	9	9										
Miscellaneous stores received from other offices	3	5	3										
				5,835	14	12							
Paper from the Stationery Office	1,403	15	10										
Miscellaneous stores from Stationery Office	135	00	2										
				1,538	15	12							
Work done by the Foundry and Shell Factory	56	1	11										
				56	1	11							
Shipping and landing charges incurred by the Marine Department	191	8	6										
				191	8	6							
				1,08,018	4	3							
Balance in favour of the Department	.....			40,600	2	3							
Total	.....			3,48,738	6	11	Total	.....			1,48,738	6	11

PHOTOGRAPHIC OFFICE, CALCUTTA.

Statement of Departmental Work done between 1st October 1884 and 30th September 1885.

Specification of Plate or Print.	Progress made.	Scale of Map.		Number of Sheets or subjects.	Negative.		Photozincographic Printing.					Silver and other Printing.			Heliogravure and Electrotyping.					Photo-collotype.		Value.	Remarks.
		Original.	Reproduced.		Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo-transfer prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.	Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo Blocks.	Electrotypes.	Photo-collotype Plates.	Photo-collotype Prints.		
General.		M. I.	M. I.																		R a. p.	
Afghanistan and Adjoining Countries	Order completed	32=1	48=1	4	5	...	5	...	1	200	200	...	..	...	...	...	...	...	...	...	93 8 3	
Ditto sheets 6, 8 and 9.	Negative and transfer print taken last year.	...	...	...	...	...	...	6	6	600	300	...	...	...	...	...	...	...	...	...	143 1 0	
Ditto ditto 5	Order completed	...	...	...	...	...	...	...	2	300	150	...	...	...	...	...	...	...	...	...	40 5 5	Reprint.
Rajputana, showing portion of Territories of Meywar, Jeypore, Jodhpur.	Negatives and transfer prints taken last year. Order completed.	...	...	...	...	...	...	4	4	100	100	...	...	...	...	...	...	...	...	...	64 7 3	
Railway Map of India	Order completed	32=1	32=1	...	...	...	...	...	18	1,800	1,800	...	...	...	...	...	...	...	...	...	523 2 6	Ditto.
Ditto with Coal and Iron localities.	.....	...	...	...	...	...	...	...	10	1,500	900	...	...	...	...	...	...	...	...	...	225 14 6	Ditto.
Sketch Map of Seistan Boundary	Ditto	16=1	16=1	1	2	...	2	1	1	25	25	...	...	...	...	...	...	...	...	...	38 12 1	
The Territories of His Highness the Khan of Kalat, Baluchistan.	Negative and transfer print taken.	16=1	16=1	1	6	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...	77 8 0	
Total	.....	...	...	6	13	...	13	11	42	4,525	3,475	...	...	...	...	...	...	...	...	...	1,206 11 0	
Provincial.																						
Map of Punjab	Order completed	32=1	64=1	1	1	...	1	4	4	800	800	...	...	...	...	...	...	...	...	...	176 14 4	
Province of Assam	Ditto	...	...	...	...	...	...	...	1	300	300	...	...	...	...	...	...	...	...	...	46 5 8	
Total	.....	...	...	1	1	...	1	4	5	1,100	1,100	...	...	...	...	...	...	...	...	...	222 4 0	
Divisional.																						
Map of Rohilkhand Division	Order completed	4=1	4=1	2	4	...	4	2	2	200	200	...	...	...	...	...	...	...	...	...	134 1 4	
Ditto Pegu Division	.....	...	...	...	...	...	..	...	4	400	400	...	...	...	...	...	...	...	...	...	152 10 8	
Total	.....	...	...	2	4	...	4	2	6	600	600	...	...	...	...	...	...	...	...	...	286 12 0	
District Maps.																						
Gurdaspur	Order completed	2=1	2=1	4	4	...	12	2	2	200	200	...	...	...	...	...	...	...	...	...	164 1 0	
Damoh	Ditto	4=1	4=1	1	2	...	2	1	1	100	100	...	...	...	...	...	...	...	...	...	53 12 4	
Peshawar with Tribal Names	Ditto	4=1	4=1	2	7	...	7	2	2	100	50	...	...	...	...	...	...	...	...	...	112 0 9	
Tirhoot	Ditto	8=1	8=1	1	2	...	2	1	1	250	250	...	...	...	...	...	...	...	...	...	63 9 6	

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Hazaribagh	Ditto	8=1	8=1	1	1	...	1	1	1	3	35	...	...	...	...	...	...	...	...	...	15	8	9	
Kangra	Negatives and transfer print taken last year.	...	...	...	...	...	...	1	3	530	530	...	...	...	...	...	...	...	...	...	83	0	6	
Dehra-Dún and Farrukhabad	Negatives and transfer prints taken only.	8=1	8=1	2	1	3	1	...	...	...	...	...	...	...	...		...	...	...	...	163	13	10	
Bijnor and Tarai	Ditto	8=1	8=1	2	1	2	1	...	...	...	...	...	...	...	...	2	...	...	...	...	87	10	11	
Bankoora, Cawnpore and Jashpur	Ditto	8=1	8=1	3	2	2	2	...	...	...	...	...	...	...	...	2	...	...	...	...	99	1	5	
Pratapgarh	Ditto	4=1	8=1	1	1	1	1	...	...	...	...	...	...	...	...	1	...	...	...	...	48	13	6	
Farrukhabad, Gurgaon, Lohardugga and Hansu.	Ditto	8=1	8=1	4	4	1	4	...	...	...	...	...	...	...	...	1	...	...	...	...	84	7	6	
Simla	Ditto	4=1	8=1	1	1	1	1	...	...	...	...	...	...	...	...	2	...	...	...	...	86	9	5	
Darjeeling	Ditto	4=1	8=1	1	1	...	1	...	...	...	...	...	...	...	...	1	...	1	...	...	48	6	0	
Hamirpur, Mainpuri, Bareilly, Jaunpur, Bulandshahr, Allahabad and Jhansi.	Ditto	8=1	8=1	7	4	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	47	5	6	
Sitapur, Meerut	.....	8=1	8=1	3	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	24	1	0	
Karnal	Ditto	4=1																						
Chumparun, Backergunge, Dera Ghazi Khan.	.....	8=1																						
Rungpore, Purneah	.....	8=1	8=1	7	7	...	7	...	...	...	...	...	...	...	...	...	...	...	...	...	81	11	6	
Chittagong	.....	6=1																						
Ludhiana	Ditto	4=1																						
Dera Ismail Khan, Dinagepore, Manbhoom, Jhang.	.....	8=1																						
Hamirpur, Bulandshahr, Allahabad, Aligarh.	.....	8=1																						
Cawnpore, Mainpuri, Gurgaon, Meerut, Rohtak.	.....	8=1																						
Sialkot, Jhansi, Hoshiarpur, Lahore, Moolton.	.....	8=1	8=1	33	26	...	26	...	...	...	...	...	...	...	...	...	...	...	...	...	307	15	6	
Amritsar, Jalpaiguri, Jaunpur, Sarun, Budaun.	.....	8=1																						
Cachar, Bankoora, Jullundur, Bhagalpur, Mirzapur.	.....	8=1																						
Kumaun, Chittagong Hill Tracts	.....	6=1																						
Hazara, Hissar, Ferozepore	Ditto	4=1																						
Kangra, Umballa, Gujrat, Peshawar, Gujranwalla, Delhi and Jashpur.	.....	8=1																						
Gurdaspur	Ditto	4=1	...	9	6	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...	71	14	0	
Garo hill, Lower Assam	Ditto	2=1	4=1	4	4	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	47	8	0	
Hissar	Ditto	4=1	4=1	1	4	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	48	12	0	
TOTAL	.....	...	...	87	80	10	88	8	10	1,215	1,165	...	...	...	...	13	...	1	...	...	1,740	2	11	
City and Cantonment Plans.																								
Ajmere City and Cantonment	Negatives and transfer prints taken, printing in progress.	1=12	1=12	6	22		22	...	...	...	...	...	...	...	...	...	...	...	...	...	263	12	0	
Allahabad Cantonment and Environs	...	...	...	...	...	...	...	...	24	910	910	...	...	...	...	...	...	...	...	...	270	0	7	Reprint.
Calcutta and Suburbs	Order completed	1= 6	1= 4	4	8	...	8	3	3	600	600	...	...	...	...	...	...	...	...	...	220	8	9	
Hissar Civil Station	Ditto	1=12	1=12	2	4	...	4	2	2	300	300	...	...	...	...	...	...	...	...	...	154	15	9	
Kasganj and Environs	Ditto	1=20	1=20	9	9	...	9	9	9	450	450	...	...	...	...	...	...	...	...	...	341	13	10	
Naini Tal	Ditto	...	...	...	...	...	...	...	1	100	100	...	...	...	...	...	...	...	...	...	26	15	0	
Rawal Pindi Cantonment and Environs	Ditto	1=12	1=12	7	13	...	13	7	7	1,400	1,400	...	...	...	...	...	...	...	...	...	697	13	0	
Simla sheets 1 to 4, 6 to 8, and 12 and 13	Ditto	1=24	1=24	9	18	...	18	9	9	1,350	1,350	...	...	...	...	...	...	...	...	...	801	3	4	
Simla Guide Plan	Ditto	1= 8	1= 6	1	4	...	4	1	1	200	200	...	...	...	...	...	...	...	...	...	107	15	3	
TOTAL	...	...	...	38	78	...	78	31	56	5,310	5,310	...	...	...	...	...	...	...	...	...	2,885	1	6	

PHOTOGRAPHIC OFFICE, CALCUTTA.

Statement of Departmental Work, &c.—continued.

Specification of Plate or Print.	Progress made.	Scale of Map.		Negatives.			Photozincographic Printing.					Silver and other Printing.			Heliogravure and Electrotyping.					Photo-collotype.		Value.	Remarks.
		Original.	Reproduced.	Number of Sheets or subjects.	Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo-transfer prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.	Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure plates Photo-electrotyped.	Heliogravure plates Photo-etched.	Heliogravure Prints.	Photo Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.		
Atlas Sheets.		M. I.	M. I.																			*R a. p.*	
Quarter sheet No. 4 N.W. with Hills	...	4=1	4=1	1	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	23 12 0	
Full sheet No. 47	...	4=1	4=1	1	6	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	65 0 0	
Quarter sheet No. 91 S.E.	To form an electrotyped duplicate.	4=1	4=1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	55 6 7	
Ditto ditto Matrix	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...		
Total	...	...	...	4	8	...	6	...	...	...	...	...	...	...	...	...	...	...	2	...	...	144 2 7	
Standard Maps.		M. I.																					
Afghanistan Survey sheets No. 29 $\frac{N.E.}{1\cdot3}$ 29 $\frac{N.W.}{2\cdot4}$	Order completed	2=1	2=1	2	8	...	8	2	2	100	100	...	...	...	...	...	...	...	...	...	...	141 4 0	
Afghanistan Survey sheet No. 12	Negatives and transfers taken only.	4=1	4=1	1	4	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50 0 0	
Ditto N.W. Trans-frontier sheets 15 N.E., S.E., 22 N.W., S.W. and N.E., 23 N.W., S.W., 27 S.E., 28 N.E. and S.W., 30 N.W.	Order completed	4=1	4=1	11	44	...	48	20	20	2,840	2,840	...	...	...	...	...	...	...	...	...	...	1,194 0 9	
Afghanistan Survey N.W. Trans-frontier sheets No. 22 $\frac{N.E.}{3\cdot4}$, 30 $\frac{N.W.}{1\cdot3}$	Ditto	2=1	2=1	4	16	...	16	4	4	600	600	...	...	...	...	...	...	...	...	...	...	365 8 9	
Afghanistan Survey N.W. Trans-frontier sheets No. 21 S.E. and 23 S.W.	Ditto	4=1	4=1	3	9	...	10	3	3	350	225	...	...	...	...	...	...	...	...	...	...	195 2 6	
Afghanistan Survey N.W. Trans-frontier sheets 29 S.W. and N.W.	Ditto	4=1	4=1	2	8	...	8	2	2	150	150	...	...	...	...	...	...	...	...	...	...	160 11 11	
Afghanistan Survey N.W. Trans-frontier sheets 29 $\frac{S.E.}{1}$	Negatives and transfers taken only.	2=1	2=1	1	4	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50 0 0	
Afghanistan Survey N.W. Trans-frontier sheets 29 S.W.	Negatives and transfers taken.	...	..	1	2	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	35 10 0	
Afghanistan Survey N. W. Trans-frontier sheets 10, 11, and 18.	Order completed	16=1	16=1	3	6	...	6	7	7	560	560	...	...	...	...	...	...	...	...	...	...	225 6 7	
Andaman Survey sheets No. 14	Ditto	1=4	1=4	1	4	...	4	1	1	150	150	...	...	...	...	...	...	...	...	...	...	98 6 8	
Assam Survey, Garo, Khasia and Naga Hills, sheets 12, 125, 126.	Negatives and transfers taken only.	2=1	2=1	3	3	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	37 8 0	
Assam Survey, N.E. Trans-frontier sheets 6 (Preliminary).	Transferred to zinc and proved and plate cancelled.	4=1	8=1	1	4	...	4	1	...	...	...	...	..	...	...	...	...	...	...	...	...	60 0 0	

Assam Survey, N.E. Trans-frontier sheet 14 N.W.	Negatives and transfer prints taken only.	4=1	4=1	1	4	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50	0	0	
Assam Survey, N.E. Trans-frontier sheets 14 $\frac{W.}{3\cdot4}$	Ditto .	2=1	2=1	2	8	...	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	0	0	
Assam Survey, N.E. Trans-frontier sheets 7, 10 and 11.	Ditto .	1=2	1=2	3	12	...	12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	200	0	0	
Assam Survey Boundary between Khasia Hills and Kamrup, 1 to 4.	Order completed	2=1	2=1	4	18	...	18	6	6	300	300	...	...	...	...	...	..	...	...	...	...	...	351	8	4	
Banda sheets Nos. 67, 68, 85, and 86	Ditto .	1=4	1=4	4	4	...	4	4	4	120	120	...	...	...	...	...	...	...	...	...	...	...	133	12	9	
Baluchistan, sheet No. 12	.....	...	...	2	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	27	8	0	
Bengal Survey, District Poorea, Killah Kurdah.	Ditto .	...	...	...	...	...	...	24	24	1,200	1,200	...	...	...	...	...	...	...	...	...	...	...	483	1	5	Negatives and transfer prints taken last year.
Bengal Survey, District Tirhoot, Tuppeh Bhutsalch and Chukley, Girjowli, Parganna Bisareh.	Ditto .	1=1	1=1	3	12	...	12	2	2	500	500	...	...	...	...	...	...	...	...	...	..		261	14	0	
Bengal Survey, District Durbhunga and Mozufferpore, sheets Nos. 82, 109 to 111, 141, 142, 174 and 198.	Ditto .	...	...	...	...	...	...	8	8	2,240	2,240	...	...	...	...	...	...	...	...	...	...	...	754	3	0	Negatives and transfer prints taken last year.
Bhopal and Malwa Survey sheets Nos. 50, 52, 54.	Negatives and transfer prints taken only.	1=1	1=1	3	12	...	12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	160	0	0	
British Burma, District Hanthawaddy, sheets 90 N.E., S.E., 91 S.W., and N.W., 97 N.E., 98 S.E., 105 N.E., N.W., S.E., S.W.	106 S.W. transferred to zinc and proved, and then cancelled. Negatives and transfer prints of others are taken. Printing in progress.	1=2	1=2	11	41	...	4	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	521	0	0	
British Burma, District Bassein, 103 S.E.	Order completed	1=2	1=2	1	2	...	2	2	1	150	150	...	...	...	...	...	...	...	...	...	...	...	86	6	2	
British Burma, District Bassein, 104 S.E., S.W., 112 N.E., N.W., S.E., S.W., 113 N.E., N.W., S.E., S.W., 121 N.E., N.W., and S.E., 122 N.W., S.W.	Negatives and transfer prints taken only of the 15 sheets the originals of which sent in this year.	1=2	1=2	15	60	...	60	15*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	817	8	0	*The zinc plates are cancelled, the originals of which were sent in for reproduction last year.
British Burma, District Pegu, 92 N.W., S.W., S.E.	Order completed	1=2	1=2	3	12	...	12	3	3	87	87	...	...	...	...	...	...	...	...	...	...	...	202	12	1	
British Burma, District Pegu, 107 N.E., N.W., S.E., S.W.	.....	1=2	1=2	4	16	...	16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	200	0		
British Burma, Tharawaddy, sheets 84 S.W. $\frac{S.W.}{1\cdot3}$ 94 $\frac{S.E.}{1\cdot3}$, 95 $\frac{N.E.}{2\cdot1}$, 96 $\frac{N.E.}{4\cdot1}$ 111 $\frac{S.W.}{1\cdot3}$ $\frac{N.W.}{3}$, and 112 $\frac{N.W.}{1\cdot3}$	Ditto .	1=4	1=4	10	40	...	40	9	9	1,350	1,350	...	...	9	...	...	...	...	...	...	...		883	4	6	Tracing prints.
British Burma, District Tharawaddy, 68 N.E., N.W., S.E., S.W., and 90 N.E., N.W., S.E.	Ditto .	1=2	1=2	4	16	...	16	7	7	550	550	...	...	...	...	...	...	...	...	...	...	...	396	7	10	
British Burma, District Tharawaddy 76 $\frac{S.E.}{4}$, 77 $\frac{S.W.}{3}$ and 83 $\frac{N.E.}{4}$	Negatives and transfer prints taken only.	1=4	1=2	3	3	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	37	8	0	
Central India and Rajputana Survey sheet 481.	Order completed	1=1	1=1	1	4	...	4	1	1	100	100	...	...	...	...	...	...	...	...	...	...	...	80	14	10	
Central India, Sunda, Dara, Nandwara Hill.	Ditto .	...	...	...	...	...	...	2	2	100	100	...	...	...	...	...	...	...	...	...	...	...	33	15	8	
Central India and Gwalior, 367, 369, 399	Ditto .	1=1	1=1	3	12	...	12	6	6	900	900	...	...	...	...	...	...	...	...	...	...	...	397	14	3	
Deccan Survey sheets (51 N.E., N.W., S.E., S.W.,) 58 N.E., N.W., S.E., S.W., 59 N.E., N.W., S.E., S.W.	Negatives and transfer prints of sheets 58 and 59 taken last year.	1=2	1=1	4	4	...	4	3	3	840	840	...	...	...	...	...	...	...	...	...	...	...	246	10	7	

Statement of Departmental Work, &c.—continued.

Specification of Plate or Print.	Progress made.	Scale of Map. Original.	Scale of Map. Reproduced.	Number of Sheets or subjects.	Negatives. Number of Negatives (Direct).	Negatives. Number of Negatives reversed and transparencies.	Photozincographic Printing. Number of Photo-transfer prints.	Photozincographic Printing. Number of Zinc Plates transferred.	Photozincographic Printing. Number of Zinc Plates printed.	Photozincographic Printing. Number of Pulls.	Photozincographic Printing. Number of Copies.	Silver and other Printing. Number of Silver Prints.	Silver and other Printing. Number of Blue Prints.	Silver and other Printing. Number of Miscellaneous Prints.	Heliogravure and Electrotyping. Heliogravure plates Photo-electrotyped.	Heliogravure and Electrotyping. Heliogravure plates Photo-etched.	Heliogravure and Electrotyping. Heliogravure Prints.	Heliogravure and Electrotyping. Photo Blocks.	Heliogravure and Electrotyping. Electrotypes.	Photo-collotype. Photocollotype Plates.	Photo-collotype. Photocollotype Prints.	Value.	Remarks.
Standard Maps—contd.		M. I.	M. I.																				
																						R a. p.	
Delhi, sheets 2 to 7	Tranforred to zinc only.	1=1	1=1	6	24	...	24	6	...	...	...	...	...	...	...	...	...	...	...	...	...	360 0 0	Zinc plate cancelled.
Hamirpur, sheets, 94 and 110	Order completed	1=2	1=1	8	8	...	8	4	4	835	835	...	...	...	...	...	...	...	...	...	...	292 1 9	
Hyderabad Survey, Raichur Circar, sheets 1 to 10.	Ditto	1=1	1=1	10	28	...	44	11	11	1,375	1,375	...	...	...	...	...	...	...	...	...	...	864 13 6	
Hyderabad Survey, Sagar Circar, sheets 50 to 63, 77 to 80 and 104 to 106.	Ditto	1=1	1=1	11	22	...	22	11	11	1,375	1,375	...	...	...	...	...	...	...	...	...	...	815 5 0	
Hyderabad Survey, Pangal Ghanpura Circar.	Ditto	2=1	2=1	2	8	...	8	2	2	150	150	...	...	...	...	...	...	...	...	...	...	158 13 3	
Hyderabad, Daverconda and Ghumpoora	Ditto	1=1	1=1	8	19	...	19	8	8	600	600	...	...	...	...	...	...	...	...	...	...	508 10 9	
Ditto Nilgonda Circar	Ditto	2=1	2=1	2	8	...	8	2	2	150	150	...	...	...	...	...	...	...	...	...	...	162 12 6	
Ditto Bhonagheer Circar	Ditto	1=1	1=1	8	32	...	32	8	8	600	600	...	...	...	...	...	...	...	...	...	...	611 1 0	
Ditto Golkonda Circar	Negatives taken last year. Order completed.	...	...	...	...	...	14	9	9	1,125	1,125	...	...	...	...	...	...	...	...	...	...	462 12 4	Including reprint of 350 copies of each plate.
Hyderabad, Koolburga Circar, 49, 75, to 77 and 101 and 103.	.....	...	...	...	...	...	...	7	14	875	875	...	...	...	...	...	...	...	...	...	...	280 5 10	
Kathiáwar, sheets, 52 and 53	.....	1=1	1=1	8	16	...	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	148 12 0	
Konkan Survey sheets	Order completed	1=4	1=4	82	233	...	234	30	34	5,288	5,288	...	...	...	...	...	...	...	...	...	...	1,445 8 9	
Konkan Survey District Thana, sheets Nos. 78 and 83.	Ditto	1=2	1=1	8	8	...	8	2	2	560	560	...	...	...	...	...	...	...	...	...	...	186 7 2	
Meerut Division, sheets 35 N.E., N.W., S.E., S.W.	Negatives and transfer prints taken only.	1=2	1=2	4	16	...	16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	200 0 0	
Meerut Division, sheets 34 and 34 S.W., 35.	.....	1=2	1=1	15	36	...	36	9	9	1,610	1,610	...	...	...	...	...	...	...	...	...	...	879 14 6	
Meerut Division, sheets 34 N.E., N.W., S.E., 51 N.W., S.W. and S.E.	.....	2=1	2=1																				
Meerut Division, sheets 21, 21 N.E., N.W., S.E., S.W., 22, 22 N.E., N.W., S.E., S.W.	Negatives and transfers taken last year. Order completed.	...	...	...	...	...	...	10	10	1,890	1,890	...	...	...	...	...	...	...	...	...	...	500 8 9	
Mirzapur, sheets No. 186 N.W., S.W.	Sheets 186 N.W. and S.W. have been printed and negatives and transfer prints of others are taken only.	1=2	1=2	7	10	...	8	4	1	150	150	...	...	...	...	...	...	...	...	...	...	158 14 4	
Mirzapur, sheets No. 186 N.E., S.E., 187 N.E., 201 S.E., 202 N.W. and N.E.	.....	1=2	1=1																				
Mysore Survey, sheets 3, 42, 51, 53, 59 to 61, 63 and 64.	.....	1=1	1=1	10	44	...	44	...	...	...	...	...	...	...	...	...	...	...	...	...	...	542 8 0	

Nepal Boundary Survey, sheets 1 to 3, 46 to 62, 62A, 63 to 67, 67A, 68, 69, 69A, 70 to 73, 73A and B, 74 to 83, 83A, 89, 90, 90A, 91, 91A, 92 to 94, 94A, 95 to 99, 99A and 100 to 104.	Order completed	1=4	1=4	82	82	...	82	88	88	1,760	1,760	...	...	...	...	...	...	...	...	...	...	2,785	4	11
Nepal Boundary Survey, sheets 105 S. and S.	.....	1=2	1=2	2	4	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	71	4	0
Oudh Revenue Survey, sheet No. 44.	Order completed	1=1	1=1	1	4	...	4	1	1	50	50	...	...	...	...	...	...	...	...	...	...	72	15	1
Punjab Survey, Districts Dera Ismail Khan, Dera Ghazi Khan and Muzaffargarh, No. 39.	Ditto . .	1=2	1=1	4	4	...	4	2	2	560	280	...	...	...	...	...	...	...	...	...	...	146	6	11
Punjab Survey, Districts Muzaffargarh and Mooltan, sheet No. 42.	Ditto . .	...	...	...	...	...	...	1	1	280	280	...	...	...	...	...	...	...	...	...	...	68	3	7
Punjab Survey, Districts Muzaffargarh and Mooltan, sheets Nos. 83 and 140.	Ditto . .	...	...	...	...	...	...	2	2	560	560	...	...	...	...	...	...	...	...	...	...	128	7	0
Punjab Survey, District Rawal Pindi, sheets 160 S.E./1 & 3 and 161 S.E./1, 3 & 4	.....	1=4	1=4	5	20	...	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	225	0	0
Punjab Survey, sheets 275, 276, 277, 278 (all in 4 sections.)	Order completed	1=2	1=2	16	32	...	56	14	16	2,400	2,400	...	...	...	...	...	...	...	...	...	...	1,152	3	4
Punjab Survey, sheets 241 S.E., 242 N.E., 244 N.E., S.E., 256 S.W., S.E.	Ditto . .	1=2	1=2	6	24	....	24	6	6	900	900	...	...	...	...	...	...	...	...	...	...	589	2	8
Punjab Survey, Cattle Farm 258 S.E./479 259 N.E./147 and N.W./469	Ditto . .	...	...	9	36	...	36	9	9	1,350	1,350	...	...	...	...	...	...	...	...	...	...	821	9	4
Punjab Survey, District Hissar, sheets Nos. 275, 276, 277, 278.	Ditto . .	1=2	1=1	16	16	...	16	4	4	1,120	1,120	...	...	...	...	...	...	...	...	...	...	472	13	10
Rajputana sheets, Nos. 100 and 103 . .	Negatives and transfer prints taken only.	1=1	1=1	2	8	...	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	0	0
Shahabad, sheets 1 to 9 and 11 to 16. .	Order completed	1=1	1=1	14	53	..	53	15	15	1,500	1,500	...	...	...	...	...	...	...	...	...	...	1,217	15	6
TOTAL .		...	...	460	1,189	...	1,204	395	384	40,250	39,845	...	...	9	...	...	...	...	...	...	...	25,426	0	2
Index Maps.																								
Nepal Boundary Survey Sheets . .	Order completed	4=1	4=1	1	4	...	4	1	1	30	30	...	...	...	...	...	...	...	...	...	...	64	8	6
Nepal Boundary Survey Sheets .	Ditto .	32=1	64=1	1	1	...	1	1	1	50	50	...	...	...	...	...	...	...	...	...	...	26	14	9
Kamrup, Hissar, and Akyab . .	Ditto .	...	full	3	3	...	3	2	2	1,050	2,200	...	...	...	...	...	...	...	...	...	...	166	8	7
Baluchistan Survey Sheets . .	.....	4=1	4=1	1	1	...	1																	
Dehra-Dún, Basti, Raipur, Merwara .	.....	...	reduced to ½.	4	5	...	5																	
Mirzapur	.....	16=1	16=1	1	1	...	1	4	4	2,100	3,850	...	...	...	...	...	...	...	...	...	...	315	9	9
Prome	Order completed	8=1	10·3=1	1	1	...	1																	
Andaman Survey	.....	...	...	...	...	...	1																	
Benares, Ghazipur, and Ballia . .	.....	...	full	1	1	...	1																	
N.-W. Provinces, Meerut Division, Survey sheets.	The copies are printed in colours.	...	reduced to ½.	1	1	...	1																	
Bassein and Henzada	.....	...	reduced to ½.	1	1	...	1	2	2	1,050	2,750	...	...	...	...	...	...	...	...	...	...	181	3	7
Hanthawaddy and Pegu	Order completed	...	reduced to ½.	1	1	...	1	...	...	2,000	...	...	...	...	...	...	...	...	...	...	...	237	8	0
Deccan and Konkan Survey sheets .	.....	...	reduced to ½.	1	1	...	1																	
N.-W. Frontier sheets	Order completed	32 =1	1·32=1 / 2·80=1	1	3	...	3	1	3	120	120	...	...	...	...	...	...	...	...	...	...	77	11	2
N.-W. Trans-frontier sheets . .	Ditto .	...	80=1	...	...	...	1	2	3	725	750	...	...	...	...	...	...	...	...	...	...	114	2	9
District Gorakhpur, Cadastral Survey .	Ditto .	8=1	8=1	1	1	...	1	1	1	50	50	...	...	...	...	...	...	...	...	...	...	25	5	10

PHOTOGRAPHIC OFFICE, CALCUTTA.

Statement of Departmental Work, &c.,—continued.

Specification of Plate or Print.	Progress made.	Scale of Map.		Negatives.			Photozincographic Printing.					Silver and other Printing.			Heliogravure and Electrotyping.					Photo-collotype.		Value.	Remarks.
		Original.	Reproduced.	Number of Sheets or subjects.	Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo-transfer prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.	Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure plates Photo-electrotyped.	Heliogravure plates Photo-etched.	Heliogravure Prints.	Photo Blocks.	Electrotype.	Photocollotype Plates.	Photocollotype Prints.		
Index Maps—contd.		M. I.	M. I.																				
																						R a. p.	
District Gorakpur Cadastral Survey	Negatives and transfer prints taken; printing in progress.	8=1	8=1	1	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11 1 6	
Ditto Sambalpur ditto	Ditto	4=1	8=1	1	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11 1 6	
Ditto Dehra-Dun ditto	Ditto	4=1	6=1	1	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11 1 6	
Ditto Kamrup ditto	Ditto	16=1	16=1	1	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11 1 6	
British Burma	Order completed	16=1	16=1	1	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11 1 6	
Ditto	Ditto	24=1	32=1	1	1	...	2	3	3	775	550	...	...	...	...	...	...	...	...	...	...	26 5 10	
Ditto	Ditto	24=1	32=1	1	1	...	2	1	1	25	25	...	...	...	...	...	...	...	...	...	...	41 2 4	
South Eastern Trans-frontier and North Trans-frontier.	.....	64=1	128=1	2	2	...	2	1	1	100	300	...	...	...	...	...	...	...	...	...	...	52 4 8	
Garo, Khasia and Naga Hills, North East Frontier, and District Gorakhpur.	Order completed	24=1	32=1	1	1	...	2	3	3	1,300	1,100	...	...	...	...	...	...	...	...	...	...	138 11 1	
Bassein Municipality	Negatives and transfer prints taken; printing in progress.	1=4	1=4	1	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18 15 0	
Central India and Rajputana Survey, sheets 1 and 2.	.....	24=1	48=1	2	2	...	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	41 4 0	Zinc plates cancelled.
Central India and Rajputana Survey, sheets 1 and 2.	Order completed	24=1	50=1	2	2	...	2	1	1	100	200	...	...	...	...	...	...	...	...	...	...	40 11 6	
Rajputana sheets	Negatives and transfer prints taken.	32=1	32=1	1	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12 14 0	
Survey operations in Punjab	Ditto	12=1	24=1	1	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11 1 6	
North-Eastern Trans-Frontier	Ditto	64=1	reduced	1	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10 10 0	
District Basti, Cadastral Survey	Order completed	...	...	...	...	...	4	1	1	68	68	...	...	...	...	...	...	...	...	...	...	38 12 0	Negatives taken last year.
Andaman Survey	Ditto	...	...	...	...	...	...	1	1	100	100	...	...	...	...	...	...	...	...	...	...	18 12 0	Negatives and transfer prints taken last year.
Ditto	Ditto	...	...	...	...	...	...	...	½	30	30	...	...	...	...	...	...	...	...	...	...	3 4 0	Reprint.
Central India and Rajputana	Ditto	...	...	...	...	...	...	1	½	100	100	...	...	...	...	...	...	...	...	...	...	17 8 3	Negatives and transfer prints taken last year.
Ditto ditto 1 and 2	Ditto	...	...	...	...	...	...	1	1	100	200	...	...	...	...	...	...	...	...	...	...	56 1 6	
Total	...	...	...	37	44	...	51	29	31	9,873	12,473	...	...	...	...	...	...	...	...	...	...	1,850 15 7	
Technical Charts.																							
Triangulation chart of Mysore Survey	Order completed	2=1	2=1	1	1	...	1	1	1	25	25	...	...	...	...	...	...	...	...	...	...	27 11 1	
Ditto ditto of Degree sheets I, II, III, Mysore T.S.	Ditto	4=1	4=1	3	6	...	6	3	3	75	75	...	...	...	...	...	...	...	...	...	...	122 10 2	

Triangulation chart of Degree sheet VIII, Khandesh T. S.	Ditto	2=1	4=1	1	2	...		1	1	25	25	...	...	...	...	...	...	...	...	...	...	41	6	6	
Triangulation chart of Degree sheet IX, Khandesh and Bombay.	Ditto	4=1	4=1	...	...	...	...	1	1	25	25	...	...	...	...	...	...	...	...	...	...	12	10	3	
Triangulation chart of Ajmere City, Rajputana T. S.	Ditto	2=1	2=1	1	1	...	1	1	1	25	25	...	...	...	...	...	...	...	...	...	...	27	4	7	
Triangulation chart of Simla Extension	Ditto	...	...	1	1	...	1	1	1	25	25	...	...	...	...	...	...	...	...	...	...	35	0	0	
Ditto ditto South Sylhet	Negatives and transfer prints taken only.	4=1	4=1	1	3	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	35	15	0	
TOTAL	...	...	...	8	14	...	14	8	8	200	260	...	...	...	...	...	...	...	...	...	...	302	9	7	
Miscellaneous Maps and Plans.																								
Reference to District Kangra	Order completed	...	...	1	2	...	6	1	1	100	100	...	...	...	...	...	...	...	...	...	...	63	2	9	
Map of the Volcanic Island of Narconda and Volcano of Barren Island.	Ditto	1=8	1=8	2	4	...	4	2	2	50	50	...	...	...	...	...	...	...	...	...	...	105	8	4	
Map of the Volcanic Island of Narconda and Volcano of Barren Island.	Ditto	do.	do.	...	...	...	2	1	1	482	964	...	...	...	...	...	...	...	...	...	...	55	15	0	
Map of the Nile Provinces, Hannuck to Khartum.	Ditto	16=1	16=1	1	5	...	5	1	1	50	50	...	...	...	...	...	...	...	...	...	...	84	3	0	
Reconnaissance in Baluchistan, by Captain Gore and Honourable Lieutenant Talbot.	Ditto	8=1	8=1	1	2	...	2	1	1	100	100	...	...	...	...	...	...	...	...	...	...	56	14	5	
District Cuttack (comprising Atlas sheets 125 S.E., S.W., 126 S.E., S.W., N.E., N.W., and 127 N.E., N.W.)	Ditto	1=4	1=2	24	24	...	24	8	8	96	96	...	...	...	...	...	...	...	...	...	...	370	5	0	
Scales to be used for Survey of India Department Maps.	Ditto	...	...	1	1	...	1	1	1	250	250	...	...	...	...	...	...	...	...	...	...	45	6	5	
Russian Alphabets and Comparative Statement of Miles and Versts.	Ditto	...	...	1	1	...	1	1	2	400	800	...	...	...	...	...	...	...	...	...	...	51	1	6	
Ditto ditto	Ditto	...	...	...	...	...	...	...	1	100	100	...	...	...	...	...	...	...	...	...	...	9	3	6	Reprint.
Specimens illustrating the symbols to be used for the different kinds of boundaries.	...	...	...	2	2	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	15	0	0	
Statement showing initials and full signatures of all officers, Survey of India Department.	Order completed	...	...	1	2	...	2	1	1	50	50	...	...	...	...	...	...	...	...	...	...	43	12	0	
New scale of 6-inch map of Calcutta	Ditto	...	...	1	2	...	2	1	1	60	120	...	...	...	...	...	...	...	...	...	...	81	5	3	
Plan of Photo. Office, 1st and ground floors	.....	...	...	2	2	...	2	2	2	24	48	...	...	...	...	...	...	...	...	...	...	50	11	8	
Ditto ditto ditto	.....	...	...	2	2	...	2	3	3	36	36	...	...	...	...	...	...	...	...	...	...	70	0	0	
Title of Cadastral map in Persian character.	.....	...	...	5	2	...	...	...	...	...	...	...	...	...	...	...	...	6	...	...	...	6	14	0	
Drawing of Office Seal	.....	...	...	6	14	2	...	...	...	...	...	8	...	...	...	...	...	3	...	...	...	122	3	0	
Copper plate ruling machine	.....	...	...	1	1	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	9	13	6	
Contour map of India, sheet 5	.....	32=1	64=1	1	1	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	8	0	
Sketch map of Seistan boundary	.....	...	...	1	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	22	6	0	Two photo-transfers supplied to Lithographic Office.
Central India and Rajputana, sheets 100, 103, and 96.	.....	1=1	4=1	3	3	...	...	...	...	...	...	...	12	...	...	...	...	...	...	...	...	22	8	0	
Bhopal and Malwa, sheets 50, 52, and 54	.....	...	...	3	3	...	...	...	...	...	...	...	12	...	...	...	...	...	...	...	...	22	8	0	
Plan of Otas, Tambak and Handoub	.....	...	...	3	3	...	3	1	1	120	360	...	...	...	...	...	...	...	...	...	...	74	11	10	
Map of countries adjacent to Sunkim and sketch map of Tehselah.	.....	...	...	2	5	...	5	2	2	240	240	...	...	...	...	...	...	...	...	...	...	126	12	9	
Table showing representative fractions	.....	...	...	4	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	22	3	0	
Mysore, sheets 60 and 61	.....	...	...	2	2	...	...	...	...	...	...	...	8	...	...	...	...	...	...	...	...	15	0	0	
Kathiwar, sheets 6, 7, 9, 12, 15, 16, 17, 22, 24, 26 to 29, 32, 33, 43, 45, 52, 53.	.....	...	...	73	73	...	...	...	...	...	...	...	250	...	...	...	...	...	...	...	...	485	8	9	
Photographs of Buldio (Rajputs)	.....	...	...	2	2	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	9	11	0	
Specimen of Topographical items	.....	...	...	1	1	...	1	...	...	...	...	...	2	...	...	...	...	...	...	...	...	10	2	0	
Route to and from Baila	.....	...	...	1	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	28	2	0	

PHOTOGRAPHIC OFFICE, CALCUTTA.

Statement of Departmental Work, &c.—continued.

Specification of Plate or Print.	Progress made.	Scale of Map. Original.	Scale of Map. Reproduced.	Number of Sheets or subjects.	Negatives. Number of Negatives (Direct).	Negatives. Number of Negatives reversed and transparencies.	Photozincographic Printing. Number of Photo-transfer prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.	Silver and other Printing. Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure and Electrotyping. Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo Blocks.	Electrotypes.	Photo-collotype. Photocollotype Plates.	Photocollotype Prints.	Value. R	a.	p.	Remarks.
Miscellaneous Maps and Plans—contd.		M. I.	M. I.																						
Portions of District Nepal, Nagpur and Warda.	.....	...	...	1	4	...	4	1	1	100	100	...	...	...	...	...	...	...	...	...	...	86	11	3	
Country round Caspian Sea	.....	...	...	1	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	30	8	0	
Mirzapur, Sheets 186 N.E., N.W., S.E., S.W., 187 N.E., 201 S.E., 202 N.E., N.W.	.....	...	...	7	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	43	12	0	
Relief map of India	.....	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	1	14	0	
Russian map of Central Asia	.....	...	...	...	...	...	...	...	...	...	...	4	...	...	...	...	...	...	...	...	...	2	8	0	
Gold medal	.....	...	...	...	...	...	...	...	...	...	...	4	...	...	...	...	...	...	...	...	...	3	2	0	
India showing Railways with Stations	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	155	10	10	
Jumna River Survey, sheets 1 to 33	.....	...	...	...	...	...	...	2	700	700	...	...	...	...	...	...	...	...	...	...	...	513	3	3	
Pay bill, Cadastral Establishment	.....	...	...	...	...	...	34	34	1,020	1,020	...	...	...	...	...	...	...	...	...	...	...	18	6	2	Zincographed.
Printers' Diary	.....	...	...	1	...	...	1	1	100	100	...	...	...	...	...	...	...	...	...	...	...	58	11	5	Ditto.
Burma and the regions adjacent	.....	...	...	1	...	...	1	1	650	650	...	...	...	...	...	...	...	...	...	...	...	28	6	1	Supplied to M. R. I. O. for record.
Route between Suakin and Berber	.....	...	...	...	...	...	...	2	100	100	...	...	...	...	...	...	...	...	...	...	...				
North-West Provinces, Punjab and Bengal.	.....	...	...	1	...	...	...	...	1	50	50	...	...	...	...	...	...	...	...	...	...	6	2	1	Do. do.
Map of South-West Persia	.....	...	...	...	...	...	...	...	...	...	...	...	...	6*	...	...	...	...	...	...	...	3	14	6	Tracing prints.
Map of Colonel Gerard's Journey to Kurdistan.	.....	...	...	...	...	...	...	...	4	100	100	...	...	...	...	...	...	...	...	...	...	34	6	9	
Rajputana, Sheets 39, 40, 43, 44, 48, 57, 61	.....	...	...	...	...	...	...	...	1	50	50	...	...	...	...	...	...	...	...	...	...	3	2	1	
British Burma, sheets 76 S.E./13, 83 N.E./2, 84 S.W./13, 90 N.W./13, N.E./4, and 91 N.W/13	.....	...	...	...	10	...	...	...	...	...	...	...	28	21*	...	...	...	...	...	...	...	14	3	6	Do. do.
Sketch map	.....	...	...	7	5	...	...	...	...	...	...	10	...	...	...	...	...	...	...	...	...	97	15	6	
Viceroy's crest	.....	...	...	1	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	46	14	0	
Colonel Tanner's sketches	.....	...	...	...	...	...	...	...	...	...	...	10	...	...	...	...	...	...	...	...	...	3	2	0	
Carved sandalwood book-stand ends	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	66	9	6	0	
Ivory carved mirror frame	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	100	17	13	6	
Ivory jewel casket (for specimen)	.....	...	...	½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	44	21	2	3	
Burmese carved wood steering chair	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	1	...	150	...	...	1	25	18	3	6	
Dr. King's brush-shading plates(specimen)	.....	...	...	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	2	12	174	1	0	
View of Zoological Garden (for specimen)	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	18	30	3	9	
Jewellery Textile fabrics	.....	...	...	...	...	...	...	...	...	...	...	158	...	...	...	...	...	...	...	...	...	36	5	4	
Bombay black-wood frames	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	223	6	0	
,, carved cabinet	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	1	...	150	...	...	...	...	156	10	0	
,, panels	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	2	...	185	...	...	...	...	273	1	4	
Red wood figures	.....	...	...	2	...	...	...	...	...	...	...	...	...	...	3	...	190	...	...	...	...	383	6	1	
Stationery box, Mysore	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	1	...	Proof	...	...	...	...	109	4	6	
Sandalwood casket	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	235	2	0	
Travancore ivory carving	.....	...	...	½	...	1	...	...	...	...	...	...	...	...	1	...	150	...	...	...	...	296	14	0	
Ivory frame, Gwalior	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	125	13	6	
Moorshedabad ivory carving	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	125	13	6	
															2	1	150					268	13	0	

View of Panjdeh	.....	...	...	1	1	2	...	...	...	...	...	...	...	...	1	2	20	...	...	...	...	163	8	8
Specimen of hill-shading	.....	...	...	1	1	5	...	...	...	...	...	...	...	...	2	2	...	...	...	...	...	372	9	0
Ivory boats	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	1	...	150	...	...	...	...	156	10	0
Old Burmese Ivory	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	1	...	150	...	...	...	...	163	8	0
Elephant tusk and old chessmen	.....	...	...	2	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	109	4	6
Part of Atlas sheet 39 N.W.	.....	...	...	1	2	5	...	...	...	...	...	...	...	...	2	6	...	...	...	...	...	543	13	0
Ivory casket from Travancore	.....	...	...	1	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	106	2	9
Cashmere copper-plate	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	...	1	50	...	...	...	...	96	14	10
Punjab carved door	.....	...	...	1	...	1	...	...	...	...	...	...	...	1	2	170	...	...	...	...	300	15	5
Moradabad tray	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	1	50	...	...	...	...	96	14	10
View of Snows	.....	...	...	1	...	2	...	...	...	...	...	...	...	...	1	...	...	...	...	...	79	2	0
Captain Durand's sketch	.....	...	...	1	1	3	...	...	...	...	...	...	...	...	1	...	...	...	...	...	83	14	0
Old ivory panel, Mysore	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	1	150	...	...	...	...	118	11	6
Jeypore brass work	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	70	2	0
Cashmere vase	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	70	2	0
Tanjore copper and silver plate	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	2	...	...	...	...	...	140	4	3
Antique brass work	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	70	2	0
Koft plate	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	70	2	0
Part of Map of Arabia	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	4	...	...	...	...	...	280	7	6
Travancore jewellery	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	70	2	0
Burmese do.	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	70	2	0
Interior of Cathedral—experimental	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	.....		
Palm house, Botanical Garden do.	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...	1	...	...	...	.....		
Microscope object do.	.....	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	.....		
Small silver ornament	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50	...	...	...	...	10	3	9
Carved doorway	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50	...	...	...	...	10	3	9
Heliogravure maps	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20	...	...	...	...	4	1	3
View of Kinchinjanga	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	...	...	...	...	2	7	3
Captain Durand's sketches	.....	...	...	...	...	...	...	...	...	...	...	120	...	...	...	...	...	...	...	...	138	14	6
Hyderabad Bidri-ware	.....	...	...	1	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	70	2	0
	.....	...	...	210	202	39	74	63	75	5,928	6,234	324	312	27	25	34	1,847	12	...	7	265	9,152	2	3
CADASTRAL SURVEY MAPS.																								
Assam.																								
Photozincographs	.....	...	...	214	214	...	218	216	216	11,448	11,448	...	...	...	...	...	...	...	...	...	...	4,050	0	0
Zincographs	.....	...	...	159	...	...	...	159	159	8,427	8,427	...	...	...	...	...	...	...	...	...	...	2,186	4	0
		...	...	373	214	...	218	375	375	19,875	19,875	...	...	...	...	...	...	...	...	...	...	6,236	4	0
Central Provinces.																								
Photozincographs	.....	...	...	43	43	...	43	8	8	264	264	...	...	...	...	...	...	...	...	...	...	128	0	0
North-Western Provinces.																								
Photozincographs	.....	...	...	943	943	...	894	900	900	11,068	11,068	...	...	...	...	...	...	...	...	...	...	13,797	12	0
Zincographs	.....	...	...	256	...	...	...	256	256	3,056	3,056	...	...	...	...	...	...	...	...	...	...	2,649	0	0
		...	...	1,199	943	...	894	1,156	1,156	14,124	14,124	...	...	...	...	...	...	...	...	...	...	16,446	12	0
British Burma.																								
Photozincographs	.....	...	...	1,763	1,763	...	1,826	1,872	1,872	65,090	65,090	...	...	...	...	...	...	...	...	...	...	29,087	6	0
Zincographs	.....	...	...	539	...	...	...	539	539	18,313	18,313	...	...	...	...	...	...	...	...	...	...	5,859	6	0
		...	...	2,302	1,763	...	1,826	2,411	2,411	83,403	83,403	...	...	...	...	...	...	...	...	...	...	34,946	12	0

PHOTOGRAPHIC OFFICE, CALCUTTA.

Statement of Departmental Work, &c.—concluded.

Specification of Plate or Print.	Progress made.	Scale of Map.		Number of Sheets or subjects.	Negatives.		Photozincographic Printing.					Silver and other Printing.			Heliogravure and Electro-typing.					Photo-collotype.		Value.	Remarks.
		Original.	Reproduced.		Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo-transfer prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.	Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.		
Bengal.		M. I.	M. I.																			R a. p.	
Photozincographs	.....	...	...	527	527	...	515	498	498	21,912	21,912	...	...	...	...	...	...	...	...	...		8,341 8 0	
Zincographs	.....	...	...	712	...	...	...	712	712	31,328	31,328	...	...	...	...	...	...	...	...	...		8,426 0 0	
	.....	...	...	1,239	527	...	515	1,210	1,210	53,240	53,240	...	...	...	...	...	...	...	...	...		16,767 8 0	
Total	.....	...	...	5,156	3,490	...	3,496	5,160	5,160	170,906	170,906	...	...	...	...	...	...	...	...	...		74,525 4 0	
ABSTRACT.																							
General Maps	.....	...	...	6	13	...	13	11	42	4,525	3,475	...	...	...	...	...	...	...	...	...		1,206 11 0	
Provincial Maps	.....	...	...	1	1	...	1	4	5	1,100	1,100	...	...	...	...	...	...	...	...	...		222 4 0	
Divisional Maps	.....	...	...	2	4	...	4	2	6	600	600	...	...	...	...	...	...	...	...	...		286 12 0	
District Maps	.....	...	...	87	80	10	88	8	10	1,215	1,165	...	...	...	...	13	...	1	...	...		1,740 2 11	
Plans of Cantonments and Cities	.....	...	...	38	78	...	78	31	56	5,310	5,310	...	...	...	...	...	...	...	...	...		2,885 1 6	
Atlas Sheets	.....	...	...	4	3	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...		144 2 7	
Standard Sheets	.....	...	...	460	1,189	...	1,204	395	384	40,250	39,845	...	...	9	...	...	...	...	...	...		25,426 0 2	
Index Maps	.....	...	...	37	44	...	51	29	31	9,873	12,473	...	...	...	...	...	...	...	...	...		1,850 15 7	
Technical Charts	.....	...	...	8	14	...	14	8	8	200	200	...	...	...	...	...	...	...	...	...		302 9 7	
Miscellaneous Maps and Plans	.....	...	...	210	202	39	74	63	75	5,028	6,234	324	312	27	25	34	1,847	12	...	7	265	9,152 2 3	
Total	.....	...	...	853	1,633	49	1,533	551	617	68,101	70,402	324	312	36	25	47	1,847	13	2	7	265	43,216 13 7	
Cadastral Maps	.....	...	...	5,156	3,490	...	3,496	5,160	5,160	170,906	170,906	...	...	...	...	...	...	...	...	...	...	74,525 4 0	
GRAND TOTAL	.....	...	...	6,009	5,123	49	5,029	5,711	5,777	239,007	241,308	324	312	36	25	47	1,847	13	2	7	265	1,17,742 1 7	
ABSTRACT OF WORK.																							
Departmental Maps and Plans	.....	...	...	853	1,633	49	1,533	551	617	68,101	70,402	324	312	36	25	47	1,847	13	2	7	265	43,216 13 7	
Cadastral Maps	.....	...	...	5,156	3,490	...	3,496	5,160	5,160	170,906	170,906	...	...	...	...	...	...	...	...	...	...	74,525 4 0	
Extra Departmental Maps and Plans	.....	...	...	849	878	13	871	285	369	53,808	68,968	3,582	...	...	2	5	2,855	...	...	48	11,374	30,324 8 4	
		...	...	6,858	6,001	62	5,900	5,996	6,086	292,815	330,276	3,906	312	36	27	52	4,702	13	2	55	11,639	1,48,066 9 11	

PHOTOGRAPHIC OFFICE, CALCUTTA.

Statement of Extra Departmental Work done between 1st October 1884 and 30th September 1885.

Name of Department.	Number of Sheets, Sections, or Subjects.	Negatives.		Photozincographic Printing.					Silver and other Printing.			Heliogravure and Electrotyping.					Photo-collotype.		Value.		
		Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo-transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.	Number of Silver Prints.	Number of Zinc Prints.	Number of Miscellaneous Prints.	Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo Blocks.	Electrotypes.	Photocollotype Plates.	Photo-collotype Prints.	R	a.	p.
Archæological Survey of India	11	2	3	...	...	...	...	...	9	...	...	2	4	...	...	...	...	...	261	0	0
Asiatic Society, Bengal	4	1	4	1	1	1	375	750	...	...	...	...	...	...	...	...	10	2,300	459	1	8
Allahabad Municipality	14	...	...	...	14	14	140	140	...	...	...	...	...	...	...	...	...	...	103	12	3
Calcutta International Exhibition Committee	8	...	2	...	...	...	...	...	1,218	...	...	...	4	2,555	...	...	17	4,024	2,168	11	3
Chief Engineer, Bengal Public Works Department	57	155	...	158	16	56	4,540	4,580	...	...	...	...	...	...	...	...	...	...	3,662	1	7
Chief Superintendent of Telegraph Stores	82	46	...	46	1	1	12	48	...	...	...	...	...	...	...	...	...	...	165	8	0
Deputy Post Master General, British Burma	1	6	...	6	2	2	1,020	1,000	...	...	...	...	...	...	...	...	...	...	234	0	6
Director General of Railways	2	8	...	8	2	2	1,120	1,400	...	...	...	...	...	...	...	...	...	...	317	7	8
Engineer to the Corporation of Calcutta	4	7	...	7	3	3	330	600	...	...	...	...	...	...	...	...	...	...	136	9	0
Executive Engineer, 1st Calcutta Division	5	4	...	4	2	2	80	80	...	...	...	...	...	...	...	...	...	...	76	0	3
Geological Survey of India	71	11	...	11	5	5	3,104	2,994	240	...	...	...	...	...	...	...	...	...	884	0	11
General Officer Commanding Rawalpindi Division	3	1	...	2	2	2	712	712	...	...	...	...	...	...	...	...	...	...	192	21	0
Government of India, Revenue and Agricultural Department	3	...	1	...	2	2	200	200	4	...	...	...	1	...	...	...	...	...	201	7	6
Ditto ditto Military Department	16	9	...	9	5	7	311	441	...	...	...	...	...	...	...	...	...	...	176	10	0
Ditto ditto Foreign Department	55	79	...	49	26	26	1,078	1,518	750	...	...	...	...	...	...	...	...	...	1,905	3	11
Ditto ditto Public Works Department	102	85	...	106	38	40	6,625	7,910	...	...	...	...	...	...	...	...	...	...	2,045	11	7
Ditto of Bengal	6	24	...	24	10	10	1,063	1,156	...	...	...	...	...	...	...	...	...	...	615	9	10
Ditto ditto Public Works Department	36	...	...	...	...	...	...	...	245	...	...	...	...	...	...	...	...	...	306	4	0
Ditto North-Western Provinces and Oudh, Public Works Department	67	67	...	67	8	8	1,800	6,825	...	...	...	...	...	...	...	...	...	...	1,052	15	11
Ditto of Madras	...	...	...	...	...	...	...	...	200	...	...	...	...	...	...	...	...	...	106	14	0
Ditto of Punjab	...	...	...	...	...	1	247	247	...	...	...	...	...	...	...	...	...	...	53	2	0
Government Architect	3	14	...	14	3	3	150	150	3	...	...	...	...	...	...	...	...	...	234	6	6
Inspector-General of Military Works	89	156	...	109	44	44	17,875	39,740	...	...	...	...	...	...	...	...	...	...	6,934	13	9
Indian Antiquary (Bombay Asiatic Society)	13	14	...	13	3	3	1,380	2,730	...	...	...	...	...	...	...	...	...	...	294	12	9
Locomotive Superintendent, Indus Valley State Railway	48	32	...	32	6	6	120	680	...	...	...	...	...	...	...	...	...	...	410	2	6
Marine Survey Office, Bombay	7	30	...	32	11	11	2,035	1,316	...	...	...	...	...	...	...	...	...	...	1,113	13	4
Manager, Eastern Bengal State Railway	1	4	...	4	2	2	200	200	...	...	...	...	...	...	...	...	...	...	114	3	9
Manager, Rajputana-Malwa Railway	2	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	22	13	0
Meteorological Reporter to the Government of India	3	5	...	5	2	4	90	90	...	...	...	...	...	...	...	...	...	...	101	7	3
North-West Provincial Gazetteer	7	6	1	6	1	1	500	500	...	...	...	...	...	...	...	...	5	650	291	0	3
Port-Commissioners, Calcutta	8	24	...	24	7	16	1,600	1,570	...	...	...	...	...	...	...	...	...	...	603	5	9
Quarter Master General in India	59	48	...	48	14	14	5,238	5,920	...	...	...	...	...	...	...	...	...	...	1,675	12	7
Sanitary Commissioner, Central Provinces	1	2	...	2	1	1	405	400	...	...	...	...	...	...	...	...	...	...	94	6	0
Secretary to the Board of Revenue, North-Western Provinces and Oudh	2	8	...	8	2	2	600	600	...	...	...	...	...	...	...	...	...	...	233	8	9
Secretary to the Defence Committee	1	1	...	1	1	1	60	50	...	...	...	...	...	...	...	...	...	...	34	8	0
Superintendent, Government Printing, Bengal	4	4	...	4	2	5	810	1,080	...	...	...	...	...	...	...	...	...	...	118	15	2
Ditto ditto ditto India	1	9	...	9	4	4	48	48	...	...	...	...	...	...	...	...	...	...	168	10	9
Ditto Carriage Wagon Department, East Indian Railway	4	14	...	14	4	4	100	100	...	...	...	...	...	...	...	...	...	...	235	7	6
Traffic Superintendent, Dacca-Mymensingh Railway	...	...	...	...	...	...	20	20	...	...	...	...	...	...	...	...	...	...	3	15	0
Trustees, Indian Museum	53	...	...	...	...	...	...	...	50	...	...	...	...	...	...	...	...	...	31	4	0
Major Bigg-Wither	...	...	...	...	...	...	...	...	16	...	...	...	...	...	...	...	...	...	8	0	0
Mr. A. W. Farmer	2	...	...	...	...	...	...	...	16	...	...	...	...	...	...	...	...	...	13	2	0
Major-General E. M. Playfair	1	1	...	1	1	1	100	100	...	...	...	...	...	...	...	...	...	...	39	7	6
Mr. Gibbs	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	500	50	0	0
Mr. W. Griggs, London	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15	4,000	1,400	0	0
Mr. Kipling	1	...	...	...	...	...	...	...	202	...	...	...	...	...	...	...	...	...	108	2	0
Mr. Royle, India Office	...	...	...	...	...	...	...	...	200	...	...	...	...	...	...	...	...	...	106	14	0
Duke of Connaught, through Revenue and Agricultural Department	...	...	...	...	...	...	...	...	400	...	...	...	...	...	...	...	...	...	213	12	0
Grand Total	849	878	13	871	285	309	53,808	88,068	3,552	...	...	2	5	2,555	...	...	48	11,374	30,324	8	4

Extract from the Report of LIEUT.-COL. J. WATERHOUSE, S.C., *Assistant Surveyor-General, in charge Lithographic Office, Calcutta;—Season 1884-85.*

Although the number of subjects does not show any large increase, the demands on the printing sections, lithographic and type, for maps and drawings, both departmental and extra departmental, and for forms have been greatly in excess of previous years; the number of copies turned out by the lithographic presses being 3,67,976 as against 1,85,196 of the previous year, or nearly double, and the type work has risen from 3,51,347 to 4,64,976 copies. This large increase is in both cases chiefly owing to the forms required for the use of the field parties, hitherto printed at the Dehra Office being printed here, as well as to the large increase in the number of forms for the cadastral parties required to meet the extensions of these surveys.

The introduction of the hand power lithographic machine, the receipt of which was reported last year, has alone enabled this office to meet these largely increased demands without any increase in establishment, and it has proved very useful in printing many small jobs of which large numbers of copies were required. It has the further advantage that the work on the stone is not worn out so quickly by the wear and tear of printing, and, as was proved by printing a form of weather chart in blue for the Meteorological Office, from retransfers, a stone that would scarcely have given 1,000 good copies by hand readily yielded some 10,000 copies without any sensible deterioration. For this reason I hope to extend the use of the machine to chalk drawings and other small work requiring particular care. The objection to the use of the machine for printing small numbers is the time taken in making ready, and attempts have been made to introduce the use of zinc plates but not very successfully as yet. The outturn of the machine, worked by hand, is about 1,000 a day.

A Harrild and Sons' demy broadside Bremner type printing machine was received from England at the close of the year. It has been set up in the Mathematical Instrument Department, being worked by the engine there at no increase of cost. The outturn is about 4,000 a day, and it bids fair to be of very great use in enabling us to cope with the constantly increasing demands for forms.

The number of maps, plans, drawings, &c., taken in hand, or printed during the year, amounts to 749, of which 227 were for the Department and 522 for other Departments. The total number of impressions or pulls in the Lithographic Printing section was 3,32,218, of which 1,60,522 were departmental and 1,71,696 extra departmental.

In the Type Printing Section 5,687 pages or items were set up and the total number of pulls amounts to 7,60,670.

The principal work completed during the year has been noticed in the abstract report printed in Part II, and need not be repeated.

The expenditure of the office during the year has been R67,772-13-7, and the value of the work performed R65,206-7-5, showing a balance of R2,566 against the Department. It may be remarked, however, that no percentage is added to the cost-rates of work done, as in other offices, in order to cover increases to stock, wear and tear and other unaccounted expenditure.

There has been some difficulty in preparing for the first time this return of expenditure. In the Photographic Office, where this form has been in use for some years, it has been the practice to show as expenditure the cost of all stores received from Europe during the year without reference to the amount actually expended, and the return is, in fact, one of expenses or liabilities incurred on account of the office during the year. This form seems to have the advantage of showing the whole liabilities incurred during the year rather than the mere actual expenditure of materials, &c., and as the consumption of stores in the Photographic Office keeps pace fairly evenly with receipts, it is sufficiently correct for all practical purposes; but if applied to the Lithographic Office, it is found that in some important items of expenditure such as *paper*, the cost of supplies during the year bears no proportion to the actual expenditure, as very little was received during the year, though the consumption from stock was large. I have therefore thought it better to show the cost of materials actually expended in the return from the Lithographic Office, leaving that from the Photographic Office the same as usual. Next year it may be possible to adopt the same mode of showing expenditure in both offices.

A 26" guillotine cutting machine by Hopkinson and Cope was received from England last year and has proved very useful in cutting paper both for this and the Photographic Office. The old machine was quite worn out. It would be impossible to meet the wants of the presses for paper of different sizes for forms, &c., without such a machine.

Mr. L. C. Cunningham, Head Draftsman, left the office on privilege leave in April and has not since been heard of, as already reported. No reason can be assigned for his absconding beyond the fact that the climate did not agree with him. His loss is felt very much, but it has not been thought necessary to fill up his place at present, and the post has temporarily been transferred to the Photographic Office to meet the wants of the newly formed Heliogravure section, which, it is hoped, will undertake much of the work which now has to be drawn in chalk.

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement of Departmental Work done between 1st October 1884 and 30th September 1885.

Specification of Stone or Print.	Lithographic Printing.							Type Printing.					Remarks.
	Progress made.	Scale of map.	Size of each sheet.	Number of sheets or subjects.	Number of stones.	Number of colored copies.	Number of uncolored copies.	Number of pages or items.	Number of pulls to each item.	Total number of pulls.	Total number of copies.	Value.	
General Maps.		In. Mls.										R a. p.	
Drawn during the year.													
Contour Map of India in 6 sheets, sheets Nos. 1, 2, 3, 4, 5 and 6.	Drawn on stone.	1 = 32	Double elephant.	6	6	...	...	...	...	...	...	757 9 0	Not yet printed.
Reduced Contour Map of India, sheet No. 5.	Photo-Litho; color stone prepared.	1 = 64	½ sheet superroyal.	1	1	...	...	...	...	...	...	42 8 0	Ditto.
Transferred from Copper Plate.													
India, showing Principal Religions.	Additions made and color stones prepared.	1 = 80	Double elephant.	1	7	...	...	...	...	...	...	127 8 0	Not yet printed.
Drawn previously but printed during the present year.													
India, illustrating Distribution of Languages.	...	1 = 96	Double elephant.	1	1	112	...	...	...	112	112	16 0 0	
India, showing Principal River Basins.	...	1 = 96	Ditto .	1	2	112	...	...	...	224	112	32 0 0	
Missionary Map of India in 2 Sheets.	...	1 = 64	Ditto .	2	4	112	...	...	...	448	112	220 0 1	
Irrigation Map of India in 6 sheets, sheets Nos. 1 to 6.	Corrections, &c., made.	1 = 32	Ditto .	6	8	112	...	...	...	896	112	509 9 4	
North-West Trans-frontier sheet, No. 27 S.-W.	Ditto .	1 = 4	Atlas .	1	1	...	200	...	...	200	200	576 6 8	
Reprints.													
India, in 6 sheets, with hills, sheets Nos. 1 to 6.	...	1 = 32	Double elephant.	6	6	...	220	...	...	1,320	220	415 10 4	
India, No. 1. . . .	...	1 = 256	Foolscap .	1	1	...	100	...	...	100	100	10 2 0	
India, showing the progress of the Imperial Survey to 1st October 1884; to accompany annual report.	Corrections made and color stones prepared.	1 = 128	Imperial .	1	3	500	20	...	...	1,520	520	159 0 3	
Provincial Maps.													
Drawn during the year.													
Nizam's Dominions, including the Assigned Districts of Berar, in 2 sections.	2nd section drawn on stone.	1 = 16	Double elephant.	1	1	...	...	...	...	...	...	250 11 0	Not yet printed.
Transferred from Copper Plate.													
Skeleton Map of Punjab and surrounding countries.	Corrections and additions made.	1 = 32	Double elephant.	1	1	...	...	...	...	...	...	93 8 0	Not yet printed.
Transferred previously from engraved sheets but printed during the present year.													
Punjab	Corrections made.	1 = 64	Foolscap .	1	1	...	500	...	...	500	500	74 2 2	
Central Provinces . .	Corrections made.	1 = 80	½ sheet foolscap.	9	4	...	4,500	...	...	2,500	4,500	175 4 8	
Punjab													
Central India Agency .													
Rajputana Agency . .													
Assam													
Bengal													
North-Western Provinces and Oudh.													
British Burma . .													
Reprints.													
North-West Provinces, in 4 sections.	Corrections made.	1 = 16	Imperial .	4	4	...	...	...	...	...	...	42 8 0	Not yet printed.
District Maps.													
Transferred from Copper Plate.													
Rungpore. . . .	Corrections and additions made.	1 = 4	Atlas . .	1	1	...	...	...	...	...	...	250 0 0	Not yet printed.
Dacca	Ditto .	1 = 4	Ditto .	2	2	...	...	...	...	...	...	119 3 0	Ditto.
Darjeeling . . .	Ditto .	1 = 4	Double royal	1	1	...	...	...	...	...	...	64 6 0	Ditto.
Shahabad . . .	Ditto .	1 = 4	Antiquarian	1	1	...	...	...	...	...	...	284 12 0	Ditto.
Transferred previously from the engraved sheets but printed during the year.													
Cachar	Further corrections made.	1 = 4	Double royal	1	1	...	61	...	...	61	61	39 10 4	
Chanda	Ditto .	1 = 4	Special .	1	1	...	150	...	...	150	150	140 11 0	
Carried over	...	...	...	49	57	948	5,751	...	...	8,031	6,999	4,129 13 10	

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement of Departmental Work, &c.—continued.

Specification of Stone or Print.	Lithographic Printing.							Type Printing.		Total number of prints.	Total number of copies.	Value.	Remarks.
	Progress made.	Scale of map.	Size of each sheet.	Number of sheets or subjects.	Number of stones.	Number of colored copies.	Number of uncolored copies.	Number of pages or items.	Number of prints to each item.			R a. p.	
Brought forward.	...	...	...	49	67	948	5,751	...	...	8,031	6,099	4,129 13 10	
Reprints.		In. Mls.											
Mymensingh	...	1 = 4	Antiquarian	1	1	...	150	...	...	150	150	121 13 6	
Sylhet	...	1 = 4	Double elephant.	1	1	...	50	...	...	50	50	16 6 6	
Plans of Cantonments and Cities.													
Reprints.													
Calcutta in 2 sheets	...	6 = 1	Double elephant.	2	2	105	...	...	...	432	198	419 9 2	
Calcutta	...	3 = 1	Super-royal	1	1	...	75	...	...	75	75	13 1 6	
Indian Atlas Sheets.													
Drawn during the year.													
Quarter sheets, Nos. 4 N. W., 14 N. W., and 14 S. W.	Drawn on stone.	1 = 4	½ sheet Atlas	3	3	...	...	...	...	...	...	454 12 6	Not yet printed.
Standard Sheets.													
Drawn during the year.													
Oudh Revenue Survey, sheets Nos. 101, 102, 117, 132, 133 and 138.	Drawn on transfer paper.	1 = 1	Double royal	6	6	...	...	...	...	...	...	3,311 6 6	Not yet printed.
District Mymensingh, sheets Nos. 343, 344 and 364.	Ditto	1 = 1	Ditto	3	3	...	...	...	...	...	...	1,414 8 0	Do.
District Jalpaiguri, sheets Nos. 271, 272, 294, 295, 296, 315, 316, 317, 318, 338 and 339.	Re-transfer made with corrections, &c.	1 = 1	Ditto	11	11	...	...	...	...	...	...	654 8 6	Do.
Drawn previously, but printed during the present year.													
Districts Bijnor, Moradabad and Tarai, sheets Nos. 20 and 46.	Corrections made.	1 = 1	Double royal	2	2	...	564	...	...		564	537 1 3	
Oudh Revenue Survey, sheets Nos. 68, 135 and 137.	Ditto	1 = 1	Ditto	3	3	...	846	...	...	846	846	784 12 9	
Index Map.													
Drawn during the year.													
Index to the Trans-Frontier of India, sheets on the scale of 1 inch=16, 8, 4 and 2 miles.	Re-transfer made with corrections, additions, &c., and color stones prepared.	1 = 128	Double elephant.	1	2	100	...	...	...	200	100	143 11 3	
Reprints.													
Index maps, Nos. 1, 5 and 8, Topographical parties on the scale of 4 inch = 1 mile, to accompany annual report.	Corrections made and color stones prepared.	1 = 32,440	Foolscap	3	3	1,500	60	...	...	3,620	1,560	329 1 7	
Index to the Indian Atlas, showing the state of the engraving and materials for engraving to 1st October 1884, to accompany annual report.	Ditto	1 = 256	Ditto	1	2	600	20	...	...	1,020	620	64 5 11	
Index to the Indian Atlas, showing the sheets that have been published to October 1884, to accompany annual report.	Ditto	1 = 256	Ditto	1	2	500	20	...	...	1,020	520	77 2 7	
Index to the sheets of Assam on the scale of 1 inch=1 mile.	Ditto	1 = 32	½ sheet double royal.	1	1	100	...	...	...	200	100	27 3 6	
Index to the standard sheets of the North-Western Provinces and Oudh on the scale of 4 inch=1 mile.	...	1 = 16	Imperial	1	1	...	50	...	...	50	50	5 12 0	
Miscellaneous maps	...	...	...	56	73	1,661	27,948	...	...	33,948	29,607	1,968 15 11	
Departmental forms	...	...	...	73 8	73 8	...	1,25,257	...	...	1,25,316	1,25,257	8,240 4 2 63 4 0	Not yet printed.
Total	...	...	...	227	400	5,417	1,60,789	...	...	1,60,322	1,66,206	22,767 9 0	
Circular Orders	...	...	...	...	...	...	...	38	6,950	...	5,750	227 9 0	
Memoranda, &c.	...	...	...	...	...	...	...	625	3,93,892	...	2,64,814	5,361 5 0	
Forms, &c., for Survey Department.	...	...	...	...	...	...	...	125	3,20,908	...	1,33,330	4,305 13 0	
Transfers of headings, foot-notes, references of published maps for Photo. and Litho. Offices.	...	...	...	...	...	...	...	4,929	32,022	...	32,022	3,481 7 0	
Rubber stamps made for Survey Department.	...	...	...	...	...	...	...	...	...	...	...	31 0 0	
Total	...	...	...	...	...	...	...	5,697	7,09,670	...	4,61,976	13,610 2 0	

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement shewing the Amount and Value of Work done for other Departments between the 1st October 1884 and 30th September 1885.

Name of other Department.	Lithographic Printing.				Total number of pulls.	Number of copies.	Value.	Remarks.
	Number of sheets or subjects.	Number of stones.	Number of colored copies.	Number of uncolored copies.				
							R a. p.	
Home Department, India	4	3	...	117	87	117	72 6 0	
Military Department, India	12	17	2,310	1,375	5,005	3,685	693 13 9	
Foreign Department, India	44	43	...	2,159	2,474	2,159	1,742 0 0	5 Photo. transfers.
	6	7	...	...	...	...	175 12 0	Not yet printed.
Revenue and Agricultural Department, India	7	7	...	2,488	2,613	2,488	206 3 2	
	5	12	...	...	...	...	518 8 0	Ditto.
Quarter Master General, India	32	21	115	3,322	2,467	3,437	1,980 9 10	
	1	2	...	...	...	...	21 4 0	Ditto.
Telegraph Department, India	7	4	...	1,160	760	1,160	110 14 5	
Public Works Department, India	23	13	...	4,657	1,971	4,657	221 4 0	
Sanitary Commissioner, India	5	8	1,316	2,010	5,145	3,326	424 9 5	
Meteorological Reporter, India	39	41	2,346	11,980	17,084	14,326	2,011 6 1	
	6	8	...	...	...	...	518 0 0	Not yet printed.
Archæological Survey of India	76	21	...	51,220	15,505	51,220	2,524 13 8	
	31	11	...	...	...	...	897 8 0	Ditto.
Geological Survey of India	11	29	3,767	3,882	20,314	7,649	2,458 14 9	
	1	1	...	...	...	...	7 0 0	Ditto.
Ordnance Department, India	4	2	...	716	412	716	91 6 3	
Consulting Engineer, India	10	7	...	550	370	550	105 8 0	
	1	1	...	...	...	...	8 4 0	Ditto.
Superintendent, Government Printing, India	32	18	...	5,909	3,675	5,909	515 8 4	
Government of Bengal	47	20	...	32,208	18,238	32,208	893 15 8	
Public Works Department, Bengal	9	9	200	564	914	764	257 7 3	
	1	1	...	...	...	...	5 8 0	Ditto.
Postal Departments, Bengal and Assam	7	8	...	355	820	355	333 4 4	
Sanitary Commissioner, Bengal	2	7	670	...	2,770	670	338 12 0	
Meteorological Reporter, Bengal	2	2	...	26,275	26,275	26,275	271 9 0	
	1	1	...	...	...	...	22 0 0	Ditto.
Board of Revenue, Bengal	9	6	2,000	2,500	7,800	4,500	333 3 0	
Controller of Military Accounts, Bengal	1	1	...	20	20	20	37 10 1	
Public Works Department, Punjab	1	1	...	1,000	500	1,000	90 2 5	
Punjab Government	9	12	415	9,212	10,892	9,057	1,247 15 1	1 Photo. transfer.
Postal Departments, North-Western Provinces and Rajputana	2	2	...	505	1,010	505	285 15 0	
	2	2	...	...	...	...	68 12 0	Not yet printed.
Port Officer and Registrar of Wrecks	2	4	155	152	617	307	143 11 3	
Stationery Office	8	8	...	2,640	2,640	2,640	264 3 0	
Office of the Inspector General of Forests	1	1	...	305	305	305	65 9 0	
Her Majesty's Mint	3	3	...	215	235	215	90 12 10	
Tirhoot State Railway	1	3	200	...	600	200	253 12 0	
Assam-Behar State Railway	7	7	...	525	525	525	224 6 0	
Eastern Bengal State Railway	4	4	...	350	350	350	246 12 0	
Rajputana-Malwa Railway	1	1	...	4,000	4,000	4,000	71 8 3	
Chief Commissioner, Central Provinces	2	9	110	...	990	110	504 7 0	
Chief Commissioner, British Burma	1	2	305	...	610	305	186 15 0	
Commissary General-in-Chief	2	2	...	...	...	...	33 0 0	Not yet printed
Director of Garrison Instruction in India	3	6	720	480	2,200	1,120	221 0 0	
General Superintendent, Horse and Mule Breeding Operations, North-Western Provinces	1	1	200	...	200	200	40 0 0	
	1	2	...	...	...	...	24 8 0	Ditto.
Secretary for Berar to the Resident at Hyderabad	2	3	205	155	665	360	88 5 0	
Executive Engineer, Pishin	1	1	...	24	24	24	3 7 3	
Director of Agriculture, Central Provinces	1	1	...	...	...	...	17 0 0	Ditto.
Asiatic Society	9	6	...	5,590	2,930	5,590	307 5 6	
Calcutta International Exhibition Committee	2	2	...	4,005	2,672	4,005	146 13 0	1 Photo. transfer.
Defence Committee	3	3	...	375	375	375	155 3 8	
Medical College	2	2	...	1,434	1,434	1,434	63 12 0	
Calcutta Municipality	5	9	1,700	900	3,200	1,900	336 1 0	
Miscellaneous Maps	3	6	...	433	433	433	142 10 0	
Total	522	433	16,133	185,667	171,698	201,770	24,266 12 0	

Statement shewing Expenditure (Dr.) and Value of Work done (Cr.) during the Survey year, from 1st October 1884 to 30th September 1885.

Dr.				Cr.			
	R a. p.	R a. p.			R a. p.	R a. p.
Superintendent's salary	6,000 0 0			Standard maps and other maps and plans, issued to the Survey of India Office	12,505 0 11	
Establishment	35,196 12 6			Miscellaneous maps issued to the Survey of India Office	1,933 15 11	
Office rent and taxes	3,840 12 0			Departmental forms	8,303 8 2	
Contingencies	1,363 6 4	46,400 14 10				22,767 9 0
Lithographic, Drawing, and Printing materials received from England	907 6 11			Miscellaneous maps and plans, Extra Departmental	24,266 12 0	
Type Printing materials received from England	123 1 8					24,266 12 0
Paper received from England	11,887 4 7	13,007 13 2		Work done in Type Department	11,867 14 6	
						11,867 14 6
Paper received from Stationery Office	7,885 15 3			Paper supplied to Photographic and other offices of the Survey of India Department	6,161 7 2	
Miscellaneous articles received from Stationery Office	39 4 4	7,925 3 7		Old tin and packing cases sent to Mathematical Instrument Office	20 5 0	
Stores received from Mathematical Instrument Office	199 4 0			Sale of waste paper	119 7 9	
Cost of repair of articles at Mathematical Instrument Office	216 13 0	416 1 0				6,301 3 11
Shipping and Landing charges incurred by the Marine Department	22 13 0	22 13 0				
Total	.....	67,772 13 7		Total	.....	65,206 7 5

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Abstract of Work performed during—

	1853-54.					1854-55.				
	Number of subjects.	Number of copies printed.	Value.			Number of subjects.	Number of copies printed.	Value.		
			R	a.	p.			R	a.	p.
Departmental maps, &c.	153	23,046	14,473	15	2	146	40,949	14,464	0	10
Ditto forms	49	54,004	4,427	15	3	81	125,257	8,303	8	2
Extra departmental maps, &c.	500	108,146	23,212	11	11	522	201,770	24,266	12	6
TOTAL	702	185,196	45,114	10	4	749	367,976	47,034	5	0
Type work	4,181	351,347	12,148	1	6	5,687	464,976	13,610	2	0
DEDUCT—								60,644	7	0
Value of transfers, &c., already included in the cost of several lithographed maps, &c.	...	...	...			...	...	1,742	3	6
TOTAL VALUE	...	...	57,262	11	10	...	...	58,902	3	6

MATHEMATICAL INSTRUMENT OFFICE, CALCUTTA.

TABLE I.

Detail of Charges debited against Provinces and Departments during the Financial Year 1884-85.

Provinces and Departments.	Receipts.	Issues.	Net Charges.
	₹	₹	₹
Assam	56	7,939	7,883
Bengal, Civil	5,390	34,897	29,507
Bengal, Military	6,570	10,648	4,078
Berar	...	94	94
Bombay, Military	3,307	645	—2,662
Bombay, Civil	...	96	96
Bombay, Military, Egypt Expedition	...	4,885	4,885
British Burma	901	8,492	7,591
Central India	18	1,007	989
Central Provinces	1,127	11,006	9,879
Forest	445	1,543	1,098
Guaranteed Railways, East Indian Railway	...	45	45
Geological Survey and Museums	201	365	164
General Administration, Foreign Department	...	315	315
Hyderabad Public Works Department	...	74	74
Indus Valley State Railway	2,147	...	—2,147
Law and Justice	...	95	95
Madras, Military	2,965	1,815	—1,150
Madras, Civil	2,457	2,198	—259
Mint	64	94	30
Marine	48	1,756	1,708
Meteorological Department	240	1,938	1,698
Miscellaneous	1,087	931	—156
Military Secretariat	...	1	1
North-Western Provinces and Oudh	71	5,095	5,024
Public Works Department, Military Works	416	2,679	2,263
Ditto Bhopal State Railway	666	...	—666
Public Works Department, Harnai Road Command	...	224	224
Punjab	1,105	18,950	17,845
Post Office	...	85	85
Political	...	171	171
Repairs of Monuments of Antiquity	...	42	42
Rajputana Public Works Department	...	557	557
Rajputana-Malwa Railway	1,207	55	—1,152
Sind-Pishin State Railway, Northern Section	...	2,942	2,942
Survey Department	17,165	51,666	34,501
Telegraph	...	311	311
TOTALS	47,653	1,73,656	1,26,003
Cash sales	...	4,308	4,308
FINAL TOTALS	...	1,77,964	1,30,311

MATHEMATICAL INSTRUMENT OFFICE, CALCUTTA.

TABLE II.

Principal Instruments purchased in India during Financial Year 1884-85.

Names of Instruments.	No.	Value.	
		₹	a.
Chains, measuring, iron, 66′	36	275	6
Compasses, drawing, common, brass, 5″	40	50	0
„ magnetic, for plane-tables, 2″ and 2½″ needles	60	360	0
„ „ pocket	22	405	0
Glasses, binocular	28	1,010	0
Hygrometers, Mason's	1	16	8
Instruments, drawing, mathematical	20	891	10
Machines, map-printing, Ordnance pattern	6	255	0
Opisometers	3	17	4
Pedometers	2	36	0
Pens, drawing, common, ivory	33	62	4
Plane-tables, deal	100	700	0
Pins for chains	2,860	283	12
Rules, carpenters', boxwood, 2′ 2 fold, 2′ 4 fold, and 3′ 4 fold	9	10	8
„ sight, for plane-tables	200	600	0
Scale architects', boxwood, single	11	55	0
Squares, optical	50	325	0
„ set, ebonite, sets	6	45	0
„ „ „ single	80	117	13
„ „ wooden „	18	23	2
Stands for plane-tables	195	1,860	0
Thermometers	52	183	4
Watches, common	6	81	0
Total of principal Instruments purchased	3,838	7,663	7
Total of all Instruments, &c., purchased	4,751	8,695	2

TABLE III.

List of principal Instruments manufactured in Workshop during Financial Year 1884-85.

Names of Instruments.	No.	Value.	
		₹	a.
Boards, drawing	57	578	8
Chains, measuring	693	6,029	4
Clinometers	113	3,219	0
Compasses, magnetic, for plane-tables	87	1085	8
Holdalls	9	180	0
Levels, water	8	37	8
Plane-tables	182	1,430	8
Pluviometers	42	644	0
Pins for chains	1,500	281	4
Rods, measuring, wooden	134	308	10
Rules, flat, electrum	15	237	0
Rules, sight, for plane-tables	178	1,743	8
Scales of sorts	2,990	1,058	2
Squares, set, ebonite, sets	10	85	14
Staves, cross or offsets	58	292	0
Staves, levelling	64	1,252	0
Stands of sorts	68	838	12
Thermometers, maximum and minimum, on same board	4	97	0
Total of principal Instruments manufactured	6,212	19,398	6
Total of all Instruments manufactured	6,214	19,401	12

MATHEMATICAL INSTRUMENT OFFICE, CALCUTTA.

TABLE IV.

List of principal Instruments repaired in Workshop during 1884-85.

Names of Instruments.	Number.
Anemometers	31
Anemographs	2
Arithmometer	1
Barometers of sorts	132
Boards, drawing	6
Chains of sorts	81
Chronographs	2
Chronometers	5
Clinometers	14
Clocks	9
Compasses, beam, drawing, &c.	587
,, magnetic for plane-tables	49
,, ,, pocket	38
,, prismatic, of sorts and sizes	170
,, proportional	8
,, surveying	93
Glasses, binocular	22
,, copying or tracing	2
Heliographs	16
Heliotropes	41
Horizons, artificial	2
Hydrometers	54
Hygrometers	8
Hydro-clinometers	2
Instruments, drawing, Mathematical	155
Lamps of sorts	9
Lenses, reading	5
Levels of various sizes	230
Machines, hand and map-printing	14
Meter current	1
Meteograph	1
Micrometers	2
Microscopes	7
Mining dial	3
Pens, drawing, of sorts	245
Pentagraphs	12
Pins for chains	711
Perambulator, English	1
Plane-tables	21
Planimeters	14
Pluviometers	8
Pointers, station	8
Prickers	22
Protractors of sorts	62
Quintants	7
Range Finders	20
Rules, flat, of sorts	150
Rules, parallel, of sorts	55
Rules, sight, for plane-tables	18
Rules, straight edges, steel	2
Scales of sorts	305
Sextants	36
Squares, optical	165
Squares, set	125
Staves, cross or offsets	2
Staves, levelling	117
Stamps for conventional signs and type-holders	6
Stands of sorts	439
T. Squares	9
Tapes, mensuring	137
Telescopes	75
Theodolites of various sizes	168
Thermometers of sorts	83
Transit Instruments	5
Zenith Sector	1
Total of principal Instruments repaired	4,831
Total of all Instruments repaired	5,278

MATHEMATICAL INSTRUMENT OFFICE, CALCUTTA.

TABLE V.

Profit and Loss Account of Workshop Branch for 1884-85.

Debits.	R	a.	Credits.	R	a.
			Value of Work done.		
Workshop Establishment (less proportion debitable to the Store Branch for cleaning and adjusting serviceable instruments) . .	32,927	1	By repairs for public officers .	12,436	11
			Ditto for store . .	21,682	1
One-third of Office Establishment . . .	2,263	7	By manufactures for ditto .	21,975	13
Workshop contingencies as distinguished from materials purchased	492	0	On prepayment . . .	893	4
			By work done for Workshop and Store Branches of Office	1,873	5
Value of materials for special work . .	13,828	0	By packing cases manufactured	3,152	4
Ditto for general Workshop use .	1,012	10			
Wear and tear of plant	1,684	11			
Half of rent at R325 per mensem . . .	1,950	0			
Printing and stationery	173	10			
Material for manufacture of packing cases .	1,891	5			
Profit .	5,587	10			
TOTAL . .	62,013	6	TOTAL .	62,013	6

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DUN.

Extracts from the Narrative Report of MR. W. H. COLE, M.A., *Deputy Superintendent, 3rd grade, in charge of the Computing and Type-printing Sections of the Trigonometrical Branch Office, Dehra-Dun,—season 1884-85.*

The percentage (33) this year under classes Computations and Press-copy, viewed collectively, has risen about 4 per cent. on that for last year, and is now about the average. The increased percentage (21) in class Accounts, Returns, Correspondence is due to the diversion to a certain extent, as last year, of the services of Mr. C. Wood to the current duties of the office of the Officiating Deputy Surveyor-General; and the increased percentage (12) in class Miscellaneous to the instruction of the newly appointed Assistant Surveyors and of Mr. McNair. The decrease (3) under class Meteorology and General Science is due entirely to the cessation of actinometric observations.

The particulars of the work done, indicated in a general manner in the preceding table, are given hereafter in such detail as appears desirable.

CLASS 2 — COMPUTATIONS (IN DUPLICATE).

South-West Quadrilateral.—Certain preliminary calculations in connection with its final reduction have been made as below :—

Triangles computed up to log. feet	50	
First deductions of λ, L and A computed	31	deductions.
Ditto ditto corrected	34	„

Working charts were prepared for the Simultaneous Reduction. The equations of condition were first written out analytically and the printed forms for computing the co-efficients *b* and *c* of the unknown quantities *y* and *z* were then filled in and the values of the co-efficients obtained. From these the co-efficients of the Indeterminate Factors were calculated in the usual manner, and the absolute terms having been previously found, the equations beteween these factors were solved and tested, the test proving that the solution had been performed with great accuracy. The values of the unknown quantities were then deduced and these will be tested by substitution in the equations of condition. There will then remain the application of these errors to the linear and Geodetic calculations and the subsequent final adjustment of the non-circuit triangles. When this work is completed, the whole of the *principal* triangulation of India west of meridian 92° will have been harmonized, or, in other words, will have been reduced to final terms.

Southern Trigon.—Observed azimuths at two stations were computed and the field computations at 26 other stations were examined, seven of which involved partial recomputation.

The work done in connection with secondary triangulation, including Colonel Lambton's, is as follows :—

Triangles computed up to feet and miles	414
Ditto ditto log. feet	210
Ditto adjusted	396

computed 6 traverses of λ, L and A, involving 70 first deductions, 39 second, 37 third and 279 ordinary.

Observed Latitudes.—This work has occupied the services of two computers during seven months of the year under report. The calculation of the latitudes of the several stations from

observations anterior to 1884-85 is now complete, with the exception of the probable errors. The preparation of the work for the press is being commenced.

Eastern Sind Meridional Series.—Principal Triangulation. The field computations of observed azimuths at four stations were examined and corrected in part, and the error-of-mean-square table of the observed angles computed.

Jodhpore Meridional Series.—Secondary Triangulation. Computed and adjusted 13 triangles, 13 single deductions of λ, L and A, and 37 deductions of heights.

South Afghanistan.—Secondary Triangulation. Computed miles of 205 triangles and 7 deductions λ, L and A.

Electro-Telegraphic Longitude.—These computations were performed by computers from this office, working entirely under Major Heaviside's supervision; they appertained principally to season 1883-84. In addition, the following calculations were made in this office to fix the positions of the Longitude stations:—22 triangles and 20 deductions of λ, L and A. The assistance rendered to Major Heaviside is equivalent to the services of a pair of computers a little over half a month.

Survey Detachment in Kashmir.—The triangulation executed by this detachment was calculated in this office, and involved the following work:—

Sides and azimuths from given λ, and L	64	deductions.
Triangles (secondary)	176	
λ, L and A „	114	deductions.
Heights „	130	„
„ by Boiling point observations	16	„

And the horizontal and vertical angle books were examined and otherwise completed. This work engaged a pair of computers for about two months.

Spirit-Levelled Heights No. 4, Bombay Presidency, and Central India Agency.—Closing errors of the sections deduced and dispersed.

Computations done under Colonel Tanner.—The aid afforded to Colonel Tanner was equivalent to the use of a pair of computers for nearly two months.

New Edition of the Auxiliary Tables to facilitate the calculations of the Survey Department. The following tables have been extended:—

Tables I to III, V, VII, XXV to XXVII, and XXXI to XXXVIII from Lat. 5° to the Equator.

Tables III, XXV to XXVII and XXXI from 36° to 40° Lat.

Tables I, II, V and VII from 39° to 40° Lat.

Class 3 — Accounts, Returns, Correspondence.

A portion of the work embraced in this class is of a purely professional nature, but the class also includes the current work of the office of the Deputy Surveyor-General, Trigonometrical Branch, in which Mr. C. Wood's services have been utilized during the year.

Class 4 — Supply.

24. Requisitions for data of various kinds have been complied with. Some of them entailed a good deal of computation and transcription.

Class 5 — Press copy.

Southern Trigon.—The whole of the introductions, seven in number, have been partially written; also a history of Colonel Lambton's work in Southern India. The compilation of the description of the principal stations has been proceeded with, those for the Great Arc, section 8° to 18°, and the Madras Longitudinal series have been finally disposed of. Abstracts of heights (up to differences of height) have been recompared for the Great Arc, section 8° to 18°, the Mangalore Meridional, and the South Konkan Coast series, those for the South-Eastern Coast and Ceylon Branch, the Bombay Longitudinal and the Madras Meridional and Coast, have been transcribed, and some progress has also been made with that of the Madras Longitudinal series. Observed azimuths at 12 stations have been abstracted.

South-East Quadrilateral.—Synoptical Volume XIIIA, South Pārasnāth and South Malúncha Series, was completed in respect to preface, table of contents, errata, addenda to description of stations and the introduction to the South Malúncha Series; and the volume is now in the hands of the binder.

North-West Quadrilateral.—Professional Volume IVA, *Supplement* to Volumes III and IV of the *Account of the Operations of the Great Trigonometrical Survey*. The Jodhpore and Eastern Sind Meridional series. Abstract of the heights recompared and abstract of observed azimuths examined, corrected and finally completed, and table of sums of squares and the e. m. s. table prepared and finally disposed of for the Eastern Sind series. Introductory chapters written out and the details of the Simultaneous Reduction finally completed.

Synoptical Volume.—The azimuth and co-ordinate lists of the Jodhpore and Eastern Sind series have been proceeded with and are now nearly ready for the press.

Synoptical Volume $\frac{1}{A}$ (*Preliminary*).—Operations in North and South Afghanistan. Triangles, Azimuth and Co-ordinate lists for South Afghanistan Triangulation were examined,

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DUN.

corrected and re-arranged, and the volume has been completed as regards preface, table of contents and errata, and is now ready for the binder.

Electro-Telegraphic Longitude Operations.—The data for fixing the positions of the longitude stations have been abstracted. Tables VIII to X for the Arc Jalpáiguri—Calcutta, and Tables XI and XII for seven arcs of season 1881-82, as also Tables I and II for eight arcs of season 1882-83, have been examined and corrected.

Miscellaneous.—Data and letter-press for the Revised Preliminary Chart of the Burma Triangulation seasons 1875-76-77 and 1879-80-81 and that for the East Coast Secondary Triangulation, season 1882-83, have been completed and finally disposed of. Polymetrical Tables II and III for a new edition of the Routes in Western Hamalayas, and M.S. of the spirit-levelled Heights No. 4, Bombay Presidency and Central India Agency, have been examined and revised. Certain tables for the new edition of the Auxiliary Tables have been abstracted, and the Survey of India Department Notes, September 1884 to March 1885, were supervised through the press.

CLASS 7 — CHARTS.

Spirit-levelled chart, No. 4, Bombay Presidency and Central India Agency, seasons 1877, 78, 1881-82-83-84, examined. Preliminary chart of the East Coast Secondary Triangulation, season 1882-83, and the Triangulation chart of South Afghanistan for Synoptical Volume $\frac{1}{4}$, have been compared and finally disposed of.

CLASS 10 — MISCELLANEOUS.

Eighteen candidates for the Junior Division of the Survey Department were examined. Ninety-four sets of observations, both to the sun and stars (on 26 days), for determination of local time were taken and reduced, and the rating of Chronometers and the Dehra Office Turret Clock were attended to as usual. Lieutenant Burrard, Mr. Eccles, and Messrs McNair, G. Wood, Skilling, and Powell have received professional instruction. Mr. Ryall's approximate formula for computing side and mutual azimuths has been tested. Some experimental calculations were made by the Traverse Tables and the Traverse Indicator to test the utility of the latter. Nine sets of observations for latitude and eight of lunar zenith distances (taken by officers of the Department for practice) were reduced. In addition to the above, several minor duties were performed.

TYPE-PRINTING SECTION.

The usual table shewing the work annually performed by this section during the past five years is given below, the unit (a page of foolscap) being the same throughout :—

	1880-81.	1881-82.	1882-83.	1883-84.	1884-85.
Pages composed	1,363	1,283	1,381	1,498	1,505
„ printed	480,672	471,616	475,586	362,386	470,979

An analysis of the pages composed furnishes the following :—

		Pages.
Of Professional Volumes	Longitude Operations	209
	Jodhpore and Eastern Sind Meridional Series	234
	Southern Trigon	58
Of Synoptical Volumes	S. Párasnáth and S. Málúncha Series	39
	Assam Longitudinal Series	17
	Operations in Afghanistan	71
	TOTAL	628
Of Spirit-levelled Heights, No. 4 Bombay Presidency and Central India Agency		94
„ Survey of India Department Notes, September 1884 to March 1885		47
„ Report on A—K's Explorations in Great Tibet and Mongolia		154
„ Mr. McNair's Report on his Explorations in Eastern Afghanistan and portions of Kafiristan		47
„ Description of Dardistan		11
„ Letter-press and data for Level Sheet No. 83 and for Level Sheet No. 12 (3rd edition)		44
„ Letter-press and data for Preliminary Charts, seasons 1882-83 and 1883-84, of secondary Triangulation along the East Coast; and for Revised Preliminary Chart of Burma Triangulation, seasons 1875-76-77 and 1879-80-81		87
„ Orders, memoranda, forms, &c.		336
For Punjab Government		5
For Forest Department		52
	TOTAL	877

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DUN.

Statement of Expenditure (Dr.) and Amounts credited (Cr.) on account of the Type Printing Section during the Survey year 1st October 1884 to 30th September 1885.

Dr.			Cr.		
	R a. p.	*R a. p.*		*R a. p.*	*R a. p.*
Superintendence	4,753 7 8		Letter press, forms, diagrams, &c., for the Survey of India Department	11,338 3 2	11,338 3 2
Establishment	6,672 0 0				
Contingencies	104 1 9	11,529 9 5			
Stores received from England	*56 0 0	56 0 0	Miscellaneous letter press, &c., Extra Departmental	372 10 3	372 10 3
Stores purchased in India	* ...	...			
Stationery (paper) from Stationery Office	*125 4 0	125 4 0			
Total	...	11,710 13 5	Total	...	11,710 13 5

* Financial year 1884-85.

Statement of Departmental Work done by the Type Printing Section between 1st October 1884 and 30th September 1885.

Specification of print.	No. of pages.	Total No. of pulls.	No. of copies.†	Value.
				R a. p.
Professional Volumes	329	63,372	510	4,216 15 3
Synoptical Volumes	115	11,686	360	1,443 10 1
Trans-Frontier Exploration Reports	172	9,060	144	1,231 1 0
Pamphlets of Spirit-levelled Heights	104	7,191	510	1,336 13 8
Auxiliary Tables	6	662	50	152 7 5
Letter press for Charts, map headings and foot-notes	178	8,448	50	423 14 7
Forms	52	9,842	200	489 9 4
Miscellaneous work done for the Trigonometrical Branch	360	43,377	Not obtainable.	2,043 12 3
	‡1,316	153,638	...	11,338 3 2

† Equal 1,448 pages of Standard (foolscap) size.
‡ Approximate number.

Statement showing the amount and value of work done for other Departments by the Type Printing Section between 1st October 1884 and 30th September 1885.

Name of other Department.	No. of pages.	Total No. of pulls.	No. of copies.	Value.
				R a. p.
Forest Department	44	5,118	Various.	318 14 8
Punjab Government	3	252	120	53 11 7
	§47	5,370	...	372 10 3

§ Equal 56½ pages of Standard (foolscap) size.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DUN.

Statement of Expenditure (Dr.) and Amounts credited (Cr.) on account of the Drawing Section during the Survey year 1st October 1884 to 30th September 1885.

Dr.						Cr.		
	R	a.	p.	R	a.	p.	R	a.	p.	R	a.	p.
Superintendence .	4,800	0	0									
Establishment . .	13,627	13	9				Maps, Charts, &c., for the Survey of India Department	18,385	14	3		
Contingencies . .	586	12	6	19,014	10	3	Maps, &c., Extra departmental .	830	8	0		
Stationery from Stationery Office .	201	12	0	201	12	0						
Total .	...			19,216	6	3	Total .	...			19,216	6	3

~~Departmental~~ Work done in Drawing Section from 1st October 1884 to 30th September 1885.

Title of Map.	Scale. In. Mls.	Remarks and Progress.
Final Charts of Triangulation.		
Assam Longitudinal Series Degree Sheets Nos. 1 to 28 .	1 = 4	In course of preparation.
Kandahar District Triangulation Chart, original corrected and supplemented.	1 = 4	For reduction to half scale. Published.
Preliminary Charts of Triangulation.		
Burma Secondary Triangulation, revised preliminary chart, seasons 1875 to 1877 and 1879 to 1881.	1 = 4	Published.
Index to points fixed by Triangulation in Northern Afghanistan.	1 = 8	Published.
Supplementary Charts of the Secondary Coast Series, seasons 1883-84, showing positions of beacons on the coast.	1 = 2	Published.
Charts of the North-Western Trans-Frontier sheets Nos. 13, 21, and 22.	1 = 8	In course of preparation.
Charts of the (Kuhsan triangulation), 3 sheets . .	1 = 4	Ditto.
Compilations.		
Level sheets in the Punjab, No. 6, (2nd edition) No. 12, (3rd edition) Nos. 67, 74, 81, 83, and 88.	1 = 2	Sheets 12, 81, and 83 published „ 6 now ready for examination.
Map of Eastern Afghanistan and Kafiristan by Mr. W. W. McNair.	1 = 12	To illustrate the Report. For Foreign Department. For reduction to 1 inch = 16 miles. Published.
Map of Turkestan, confidential edition . . .	1 = 32	Ditto.
Index to Trans-Frontier maps	1 = 64	Ditto.
„ Sheets of South-Western Asia . . .	1 = 128	Ditto
South-Western Asia Sheets, Nos. 70, 71, and 72 . .	1 = 8	Parts of Persia. In course of preparation.
North-Eastern Trans-Frontier Sheet, No. 5 . . .	1 = 8	Ditto ditto.
Northern Trans-Frontier Sheets, Nos. 20 and 21 . .	1 = 8	Ditto ditto.
„ „ „ Nos. 17, 18, 25, and 26 .	1 = 16	Ditto ditto.
Mussooree and Landour Guide map, 3rd edition . .	1 = 1	Temporarily suspended.
Map of Kishenganga Valley	1 = 4	In course of preparation.
Miscellaneous.		
Drew diagrams of bench marks for level Sheet, No. 81 .	...	For publication.
Drew two forms, professional	...	
Examined and corrected Káthiáwar Survey Sheets, Nos. 6, 7, 9, 15, 16, 17, 26, 27, 28, 29, 32, 52, and 53 (2nd edition).	1 = 1	For reduction.
Examined and corrected Gujarát Survey Sheets, No. 157 in 4 sections, No. 158 in 2 sections.	1 = 1	For publication.
Examined and corrected Gujarát Survey Sheets, No. 180 in 3 sections, No. 181 in 14 sections, No. 182 in 2 sections, No. 183 in 2 sections, No. 190 in 2 sections.	1 = 1	Ditto.
Examined and corrected Gujarát Survey Sheets, Nos. 180 and 182.	1 = 1	For reduction.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DUN.

Departmental Work—(contd.)

Title of Map.	Scale.	Remarks and Progress.
	In. Mls.	
Examined and corrected Gujarát Survey Sheets, Nos. 133 and 159 joint sections.	1 = ½	For publication.
Examined and corrected Cutch Survey Sheets, Nos. 3, 4, 12, 13, and 23, 24, 36, 37.	1 = 2	Ditto.
Examined and corrected Cutch Survey Sheets, Nos. 38, 39, 40, 41.	1 = ¼ about	For reduction.
Examined and corrected Atlas reductions of Sheets, Nos. 157 and 104 of Gujarát Survey.	1 = 4 about	For Engravers, Calcutta.
Examined and corrected Atlas reductions of Sheets, Nos. 6, 7, and 29 of Cutch Survey.	1 = 4	Ditto ditto.
Examined and corrected Index Sheets, to Cutch and Gujarát Survey.	...	For Annual Report.
Examined and corrected Index chart of Triangulation of India.	...	Ditto.
Prepared and copied 27 tracings of level charts between Cawnpore and Allahabad at Captain Clibborn's Office, Cawnpore.	1 = ½	For level sheets.
Examined 318 proofs of maps and charts	...	
Coloured 11,850 maps	...	
Prepared a trace of Sheet No. 6, North-East Trans-Frontier.	...	For Colonel Tanner.
Inserted boundary of Travancore on charts of Southern India.	4 = 4 1 = 8	For the use of the Computing section.
Prepared diagrams of figures to illustrate Electro-telegraphic arcs of Longitude.	...	For Annual Report.
Corrected chart illustrating pamphlet No. 4	...	
Spirit-levelling operations in Bombay Presidency and Central India Agency.	1 = 16	For publication.
Drew diagrams of bench marks for level Sheet No. 67	...	Ditto.
Prepared Plane table sections with graticules and points of Sheets Nos. 27 N. E. / 2 & 4, 3 N. W. / 1 & 3, and 3 W. W. / 2 & 4 of Trans-Frontier sheets.	1 = 4	For Colonel Woodthorpe.
Prepared graticule sheets between 24° × 36° Lat. (16 on 8-mile and 1 on 16-mile scale) in No. 17.	1 = 8 1 = 16	For Quarter-Master General and for publication.
Graticule sheets between 24° × 36° Lat. (1 on 8-mile and 2 on 16-mile) in No. 3.	1 = 8 1 = 16	In course of preparation.
Examined and corrected 31 sheets of Nepal Boundary Survey.	1 = ½	For publication.
Drew a plan of Survey Office, Dehra-Dún, with proposed Drawing and Photographic sections.	10 feet.	Ditto.
Prepared descriptions of bench marks for level sheets	...	
Prepared papers and plots of explorer M. S.'s traverse for comparison with Regel's bend of the Oxus river.	...	
Inserted Pemberton's route on 23 photozinco copies of Index to N.E. Trans-Frontier sheets and Sketch maps of explorer's reports.	64 miles.	
Tabulated geographical material (explorations for Trans-Frontier sheets).	...	
Tabulated geographical material (explorations for South-Western Asia sheets).	...	
Compilation, Examination, &c.		
Map of Ránikhet Cantonment	1 = ½	For North-Western Provinces Gazetteer.
Map of a portion of the North-Western Provinces showing proposed Dehra-Dun Railway.	1 = 32	For Mr Hope, Secretary, Dehra-Dun Railway, enlarged to 24-mile scale.
Completed, in respect to headings and foot-notes, Forest maps before sending to press, and examined 107 proofs after.	various.	For Forest Department.
Examined 48 pages of Janam Sakhi of Guru Nanak	..	For Punjab Government.
Prepared graticules between 26° & 31° Lat. and 56° & 63° Long. with list of points.	1 = 8	For Quarter-Master General.
Made tracings of levels in Sind-Ságar Doáb	1 = 2 about	For Punjab Northern State Railway.
Incorporated Mr. McArthy's survey on Foreign office map of Eastern Indo-China.	1 = 14	For the Foreign Department.
Colouring Maps.		
Sketch map of country 10 miles round Allahabad, 185 copies.	...	For General Officer Commanding Allahabad Division.
Map of a portion of the North-Western Provinces showing proposed Dehra-Dún Railway, 100 copies.	...	For Mr. Hope, Secretary, Dehra-Dún Proposed Railway Committee.
S. W. Turkomania, 15 copies	...	For Foreign Department.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DUN.

Statement showing the Value of Work done for other Departments by the Drawing Section between 1st October 1884 and 30th September 1885.

Name of other Department.	Value. R a. p.
For N.-W. P. Gazetteer	30 0 0
„ Forest Department	184 0 0
„ Foreign do.	358 0 0
„ Punjab Government	41 0 0
„ General Officer Commanding Allahabad Division	23 0 0
„ Quarter Master General	125 0 0
„ Secretary Dehra-Dún Proposed Railway Committee	27 8 0
„ Punjab Northern State Railway	42 0 0
TOTAL	830 8 0

Statement of Expenditure (Dr.) and Amounts credited (Cr.) on account of the Photo-zincographic Section during the Survey year 1st October 1884 to 30th September 1885.

DR.			CR.		
	R a. p.	R a. p.		R a. p.	R a. p.
Superintendence	2,400 0 0		Maps, forms, diagrams, &c., for the Surveyor-India Department	22,480 6 0	
Establishment	8,995 0 0				22,486 2 0
Contingencies	261 14 6		Miscellaneous maps, plans, &c., extra departmental	3,205 11 6	
		11,656 14 6			3,205 11 6
Chemicals and Stores from England	*1,878 0 0				
Paper received from England	*1,769 0 0				
		3,647 0 0			
Chemicals and Stores purchased in India	*70 3 0				
Stationery (paper) from Stationery Office	11,111 13 0				
		11,181 16 6			
Shipping and landing charges	59 5 0				
		59 5 0			
Balance to credit of Department	...	9,827 12 6†			
TOTAL	...	26,672 13 0	TOTAL	...	26,672 13 0

* Financial year 1884-85.

† NOTE.—*In addition* to this credit, the Section has realized (by sale of maps, sheets, &c.) and paid into the Treasury the sum of Rs.1,068-0-7 (exclusive of R320 from Perak Government and Rs. 26-9 from Secretary, Dehra-Dun Proposed Railway Committee).

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DÚN.

Statement of Departmental work done by the Photozincographic Section between 1st October 1884 and 30th September 1885.

Specification of Plate or Print.	Photozincographic Printing.								Type-Printing.		Total No. of pulls.	No. of copies.	Value.	Remarks.
	Progress made.	Scale of maps.	Size of each sheet.	No. of sheets, sections or subjects.	No. of negatives.	No. of Photo. transfer prints.	No. of zinc plates.	No. of silver prints.	No. of blue prints.	No. of pages or items.	No. of copies.			
		1 inch =											R a. p.	
Sketch Map of country 10 miles round Allahabad	F.	1 mile	D.E.	1	6	6	1	...	...	...	...	23	23	18 14 0	
Naro Hill and Environs (proposed site of cantonment)	,,	1 ,,	,,	2	12	12	2	...	...	...	...	12	6	217 2 0	
Geological Map of India	,,	165 miles	A.	1	5	5	1	...	...	...	...	64	64	16 8 0	
Kumaun and Garhwál Forest Maps, Nos. 1, 2, 15, 19, 20, 37, 42, 50, 51, 59, 79	,,	1 mile	D.E.	11	66	76	11	...	...	...	...	503	503	723 9 0	
Kumaun and Garhwál Forest Map, No. 27	(a) ,,	1 ,,	,,	1	...	...	1	...	...	...	...	10	10	3 2 0	
Do. do. No. 20 (part of)	,,	1 ,,	1 ,,	1	1	1	1	...	...	...	...	6	6	1 14 0	
Do. do. Nos. 2, 12, 13, 16, 17, 18, 21, 22, 23, 25 to 28, 30 to 36, 38 to 41, 44 to 49, 52, 53 to 57	,,	1 ,,	1 ,,	36	36	...	...	36	...	...	...	...	36	130 6 0	
Dehra-Dún Division Forest Map	,,	4 miles	1 A.	1	2	2	1	...	...	...	...	24	48	12 3 0	
Traverse Indicator	(a) ,,	...	1 D.E.	1	2	2	1	...	...	...	...	42	42	13 5 0	
Index to Melghat Taluk, Berar Forest Survey	,,	8 miles	1 A.	1	1	2	1	...	...	...	...	26	52	10 0 0	
Sutlej Forest, Bashahr Division	,,	4 ,,	,,	1	1	1	1	...	...	...	...	22	45	11 8 0	
Dadi and Raisangarh Forest, No. 1	,,	1 mile	D.E.	1	6	6	1	...	...	...	...	47	47	14 14 0	
Tiri and Garhwál Forest	,,	1 ,,	,,	2	12	12	2	...	...	...	...	100	50	142 12 0	
North-Western Provinces, Forest School Circle	,,	4 miles	,,	1	6	6	1	...	...	...	...	48	48	17 5 0	
Plates of Insects (for Forest Department)	,,	...	1 ,,	13	15	15	4	...	...	...	...	14	32	8 0 0	
Ellichpur Taluk, Forest Map	,,	1 mile	,,	1	8	8	1	...	...	...	...	46	46	89 6 0	
Berar Forest, No. 14 (Field sheets)	,,	1 ,,	1 ,,	2	2	...	...	2	...	...	...	...	2	7 15 0	
Village Field Book (Forest form)	,,	...	1 ,,	1	...	...	1	...	...	...	...	33	132	20 6 0	
Heights (Forest form)	,,	...	1 I.	1	1	4	1	...	...	...	...	208	208	43 2 0	
Janam Sakhi (pp. 390—461)	,,	...	1 S.E.	18	14	14	7	...	...	...	...	119	25*	20 11 0	* Of each sheet.
Siálkot City Survey	,,	200 ft.	D.E.	1	8	8	1	...	...	...	...	30	30	89 14 0	
General Map of Krian and Kuran (Straits Settlement)	,,	1 mile	,,	8	60	60	8	...	...	...	...	328	328	401 11 0	
Ránikhet Cantonment	,,	1 ,,	1 A.	1	1	2	1	...	...	...	...	52	105	10 1 0	
Part of North-Western Provinces showing proposed Dehra-Dún Railway	,,	24 miles	1 D.E.	1	2	2	1	...	...	...	...	27	27	10 13 0	
Káthiáwar Survey, Sheet No. 14 (2nd Edition)	,,	1 mile	,,	1	9	10	1	...	...	...	...	138	138	228 11 0	
Do. do. No. 19 (2nd Edition) and No. 23 (2nd Edition)	,,	1 ,,	,,	2	18	20	2	...	...	...	...	281	281	457 14 0	
Káthiáwar Survey, Sheet No. 16	(a) ,,	1 ,,	,,	1	...	...	1	...	...	...	...	40	40	3 2 0	
Do. do. No. 13 (2nd Edition) and No. 18 (2nd Edition)	,,	1 ,,	,,	2	18	20	2	...	...	...	...	267	267	456 1 0	
Nepal Boundary Survey, Sheets Nos. 13A to 25, 44 and 45	,,	1 ,,	,,	15	95	100	15	...	...	...	...	206	206	2,002 11 0	Preliminary issues.
Do. do. do. Nos. 13A to 27	,,	1 ,,	D.E.	15	33	103	15	...	...	...	...	812	812	1,701 2 0	Final issues.
Do. do. do. No. 28	In press	1 ,,	,,	1	6	7	1	...	...	...	...	5	5	75 1 0	Do.
Darjeeling Revisionary Survey	F.	1 ,,	D.E.	4	32	32	4	...	...	...	...	580	580	786 0 0	
Carried over	...	...	...	...	...	...	...	...	...	...	...	...	...	...	

Statement of Departmental work done by the Photozincographic Section—continued.

Specification of Plate or Print.	Photozincographic Printing.								Type-Printing.		Total No. of pulls.	No. of copies.	Value.	Remarks.
	Progress made.	Scale of maps.	Size of each sheet.	No. of sheets, sections or subjects.	No. of negatives.	No. of Photo. transfer prints.	No. of zinc plates.	No. of silver prints.	No. of blue prints.	No. of pages or items.	No. of copies.			
													R a. p.	
Brought forward	...	...	...	...	...	...	...	...	...	...	..	...	...	
Gujarát Survey, Sheets, Nos. 132, 148, 105	(a) F.	1 inch= 1 mile	D.E.	3	...	10	3	...	...	...	...	136	136	151 1 0	
Do. do. Nos. 132, 147, 107, 109	(a) „	1 „	„	4	...	..	4	...	...	..	...	191	191	41 12 0	
Do. do. Nos. 130, 189	„	1 „	„	2	18	20	2	...	...	...	...	315	315	466 2 0	
Do. do. No. 130, sections 1, 2, 3	„	1 „	„	3	18	18	3	...	...	...	...	262	262	431 0 0	
Surat City and Cantonment	„	1 „	D.R.	2	12	12	1	...	...	...	...	114	57*	262 10 0	* Of each part.
Do. do.	„	1 „	D.E.	6	36	36	6	...	...	...	...	318	53*	889 1 0	* Do.
Gujarát Survey, Sheet, No. 147, sections 1 and 4	(a) „	1 „	„	2	...	...	2	...	...	...	...	22	22	4 12 0	
Do. do. No. 122, sections 2, 3 and 4	(a) „	1 „	„	3	...	...	3	...	...	...	...	36	36	8 6 0	
Do. do. Nos. 120 and 146, joint section	(a) „	1 „	„	1	...	...	1	...	...	...	...	11	11	3 4 0	
Do. do. No. 131, sections 1 and 2	(a) „	1 „	„	2	...	...	2	...	...	...	...	20	20	4 7 0	
Do. do. No. 148, sections 1, 2, 3	(a) „	1 „	„	3	...	...	3	...	...	...	...	17	17	4 1 0	
Do. do. No. 149, sections 1, 2, 3	(a) „	1 „	„	3	...	...	3	...	...	...	...	19	19	4 5 0	
Do. do. No. 151, section 1	(a) „	1 „	„	1	...	..	1	...	...	...	...	10	10	3 1 0	
Do. do. No. 155, section 1	(a) „	1 „	„	1	...	...	1	...	...	...	...	11	11	3 4 0	
Do. do. No. 189, sections 1, 3, 4, 5, 10, 11, 12	(a) „	1 „	„	7	...	42	7	...	...	...	...	100	100	533 2 0	
Gujarát Survey, Sheet, No. 190, sections 2 and 4	(a) „	1 „	„	2	...	12	2	...	...	...	...	29	29	153 14 0	
Do. do. No 150, sections 1, 3, 4	(a) „	1 „	„	3	...	18	3	...	...	...	...	25	25	209 0 0	
Dehra-Dún and Siwaliks, Sheet No. 25	(a) „	1 „	„	1	...	6	1	...	...	...	...	38	38	164 6 0	
Do. do. Sheets Nos. 1, 15, 16, 17, 33, 34, 35	(a) „	1 „	„	7	...	49	7	...	...	...	...	197	197	645 11 0	
Kumaun and Garhwál, sheet No. 29 (contoured)	(a) „	1 „	„	1	...	...	1	...	...	...	...	42	42	9 3 0	
Upper Oxus Valley	(a) „	12 miles	„	4	...	24	4	...	...	...	...	300	75*	381 0 0	* Of each sheet.
Sketch Map (revised) of A—K's explorations in Tibet and Mongolia	(a) „	16 „	„	3	...	24	3	...	...	...	...	699	233*	371 12 0	* Do.
Index to ditto	(a) „	64 „	„	1	...	...	1	...	...	...	...	285	285	33 11 0	
Plan of Lhasa	(a) „	½ mile	Atlas.	1	...	4	1	...	..	..	...	294	294	85 4 0	
Sketch Map of Explorer's Routes	(a) „	64 miles	D.E.	1	...	...	1	...	...	...	...	12	12	2 4 0	
North Waziristan and the Dawar Valley	(a) „	2 „	„	1	...	...	1	...	...	...	...	108	108	13 9 0	
South Waziristan	(a) „	2 „	„	2	...	...	2	...	...	...	...	237	237	41 10 0	Including Preliminary issue.
Dardistan or Shináki including Chilás	„	4 „	½ „	1	4	8	1	...	...	...	...	572	572	177 12 0	Chiefly for Annual Report, 1883-84.
Turkestan, 6th Edition	(a) „	32 „	„	4	...	28	4	...	...	...	...	969	543	11 0	
Index to ditto	(a) „	...	½ „	1	...	1	1	...	...	...	...	113	226	22 15 0	
Turkestan, confidential edition	„	32 miles	„	4	26	36	4	...	20	...	...	1,276	1,276	927 9 0	
Index to ditto	„	...	½ „	1	1	1	1	...	...	...	...	167	334	45 0 0	
Afghanistan	(a) „	24 miles	„	2	...	14	2	...	...	...	...	420	210*	274 10 0	
Plan of Khatmandu	„	¼ mile	½ A.	1	4	4	1	...	...	...	...	2	2	24 0 0	
Dehra Ismáil Khan Frontier	(a) „	..	D.E.	1	...	...	1	...	...	...	...	21	21	4 9 0	
Map illustrating Mr. McNair's Journey *viâ* the Malakand Pass to Gilgit	(a) „	4 miles	„	2	...	...	2	...	...	...	...	38	19*	4 0 0	* Of each part.
Do. do. do.	„	12 „	½ „	1	2	2	1	...	4	...	...	4	4	43 6 0	
Eastern Afghanistan and Kafiristan ditto	„	16 „	½ „	1	4	4	1	...	...	...	...	64	64	71 11 0	

Trans-Frontier, sheet No. 9 (*old series*)	,,	16	,,	,,	1	...	...	1	...	...	...	...	34	34	7	13	0	
Baluchistan Survey, Plane-table sections	,,	2	,,	½ ,,	6	15	...	...	60	...	...	...	...	60	158	6	0	
North-East Trans-Frontier, No. 7 $\frac{N.W.}{1}$	,,	2	,,	,,	1	8	8	1	...	...	...	...	188	188	201	5	0	
Do. do. No. 7 $\frac{N.W.}{3}$	,,	2	,,	,,	1	8	8	1	...	...	...	...	180	180	200	5	0	
Do. do. No. 6	,,	8	,,	,,	1	6	6	1	...	...	...	...	671	671	201	2	0	Chiefly for Annual Report, 1883-84.
South-West Asia Index	,,	128	,,	I.	1	4	4	1	...	...	...	...	16	16	85	15	0	
Graticule sheet, 24° to 26°	In press	8	,,	D.E.	1	8	8	1	...	...	...	...	8	8	155	13	0	
Do. 28° to 30° North-West Trans-Frontier	,,	8	,,	,,	1	7	7	1	...	...	...	...	10	10	156	1	0	
Do. 30° to 32° do. do.	,,	8	,,	,,	1	7	7	1	...	...	...	...	26	26	159	5	0	
North-East Trans-Frontier Index	,,	64	,,	,,	1	4	4	1	...	...	...	...	54	54	74	10	0	Preliminary issue.
North-West do. do.	,,	64	,,	,,	1	8	8	1	...	...	...	...	54	54	178	15	0	Do.
Index to Points in Northern Afghanistan	,,	8	,,	,,	2	16	16	2	...	...	...	...	38	19*	341	7	0	* Of each part.
Do. do. Gujarát Survey	,,	24 miles		¼ A.	¼	2	4	2	...	...	...	...	296	592	93	11	0	Chiefly for Annual Report, 1883-84.
Do. do. Cutch do.	,,	18	,,	¼ ,,	1	2	4	2	...	...	...	...	314	628	95	11	0	
Diagram of Arcs of Longitude measured by the Electric Telegraph	,,	...		¼ ,,	1	1	4	1	...	...	...	...	252	504	81	5	0	For Annual Report 1883-84.
Diagram of the South-East Quadrilateral of the Great Trigonometrical Survey of India	,,	...		¼ D.E.	1	¼	4	4	...	...	...	...	205	410	71	14	0	For Synoptical Vol. XIII A.
Reduction Chart of Principal Triangulation of the Jodhpore Series	,,	8 miles		½ ,,	1	...	6	1	...	...	...	...	234	234	101	2	0	For Professional Vol. IV A.
Diagram of Figures (Polygonal) of the South Pársnáth Meridional Series	,,	8	,,	¼ ,,	¼	1	4	1	...	...	...	...	90	360	69	1	0	For Synoptical Vol. XIII A.
Diagram of Figures (Polygonal) of the South Mahúncha, Meridional Series	,,	8	,,	¼ ,,	1	1	2	1	...	...	...	...	189	378	58	7	0	Do. do.
Burma Triangulation, seasons 1877—80, Preliminary Chart (revised)	,,	4	,,	,,	1	8	9	1	...	...	...	...	67	67	118	11	0	
East Coast Secondary Series, seasons 1882-83, Preliminary Chart	,,	2	,,	,,	2	12	12	2	...	...	...	...	124	62*	258	1	0	* Of each part.
Secondary Coast Series, seasons 1883-84, Supplementary Preliminary Chart	,,	2	,,	,,	2	16	16	2	...	...	...	...	138	138	362	1	0	
Burma Triangulation, seasons 1875-81, Preliminary Chart (revised)	,,	4	,,	,,	1	9	9	1	...	...	...	...	172	65	207	15	0	
Polymetrical Tables	,,	...		½ ,,	1	2	4	1	...	...	...	...	514	1,028	102	7	0	For pamphlet of Routes in the North-Western Provinces, Kashmir, &c.
Level Chart, No. 12 (3rd Edition)	,,	2 miles		,,	1	6	6	1	...	...	...	...	105	105	147	13	0	
Do. Nos. 81 and 83	,,	2	,,	,,	2	12	12	2	...	...	...	...	209	209	259	5	0	
Drawings of Bench-Marks for Level Charts, No. 12 (3rd Edition), 81 and 83	,,	...		½ D.R.	6	7	7	3	...	...	...	...	1,012	779	204	4	0	
Chart of Spirit-levelling Operations, seasons 1877-78, 1881-84	,,	24 miles		½ D.E.	1	5	5	1	...	...	...	...	536	536	146	10	0	For pamphlet of Spirit-levelled heights, No. 4 Bombay Presidency and Central India Agency.
Plans showing present and proposed accommodation in the Trigonometrical Branch-Office, Dehra-Dún	,,	10 ft.		D.R.	2	6	6	2	...	...	...	...	23	23	128	6	0	
Mirzapur Survey Sheets	,,	½ mile		D.E.	½	12	12	2	...	12	...	...	12	12	253	0	0	
Conventional Signs (for use of Field Survey of Ajmere-Merwara)	,,	....		½ ,,	1	2	2	1	...	...	...	...	104	104	52	6	0	
Miscellaneous Forms, *&c., &c.*, for departmental and office use	,,	...		...	49	23	113	49	...	...	...	...	16,067	10,190	2,735	8	0	
TOTAL	...	...		...	334	822	1,226	268	98	36	...	...	33,549	28,490	22,416	2	0	

REFERENCES.—D.E. Represents Double Elephant.
A. ,, Atlas.
I. ,, Imperial.
S.R. ,, Super-royal.
D.R. ,, Double Royal.

(a) Additional Prints of previous publications.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DUN.

Statement showing the Amount and Value of Work done for other Departments by the Photozincographic Section between 1st October 1884 and 30th September 1885.

Names of other Departments.	Photozincographic Printing.						Type-Printing.		Total No. of Pulls.	No. of Copies.	Value.	Remarks.
	No. of Sheets or Sections or Subjects.	No. of Negatives.	No. of Photo. transfer prints.	No. of Zinc Plates.	No. of Silver prints.	No. of Blue prints.	No. of Pages or Items.	No. of Copies.				
											R a. p.	
General Officer Commanding Allahabad Division.	3	18	18	3	...	...	...	...	387	166	217 1 0	
Punjab Government	19	22	22	8	...	...	...	...	602	{800* 30	372 10 0	* Of each of 18 Sheets of Janam Sakhi.
Quarter Master General	1	4	4	1	...	...	...	...	4	4	48 0 0	
Perak Government	8	60	60	8	...	...	...	...	800	800	970 12 0	Has paid R320.
North-Western Provinces Gazetteer.	1	1	1	1	...	...	...	...	268	536	41 4 0	
Foreign Department	1	2	2	1	...	...	...	...	12	15	14 3 0	
Forest Department	75	164	140	28	76	445	...	...	3,380	4,705	2,513 15 0	
Secretary, Dehra-Dun Proposed Railway Committee.	1	2	2	1	...	...	...	...	100	100	39 14 0	Has paid R36-9.
Total	109	273	249	51	76	445	...	...	5,241	6,475	4,266 11 0	

Statement of Expenditure (Dr.) and Amounts credited (Cr.) on account of the Photo Heliographic Section during the Survey year 1st October 1884 to 30th September 1885.

Dr.	R a. p.	R. a. p.	Cr.	R. a. p.
Superintendence	600 0 0			
Solar Photographer	4,800 0 0			
Establishment	919 0 0			
Contingencies	5,293 2 0	11,612 2 0		
Chemicals and Stores from England*	2,489 0 0		Value of negatives and Silver Prints taken for the Solar Physics Committee under authority from the Secretary of State for India (Debitable to the Industry, Science and Art Department)	14,164 0 0
Chemicals and Stores purchased in India	62 14 0	2,551 14 0		
Total	.....	14,164 0 0	Total	14,164 0 0

* Financial year 1884-85.

Table of Working Facts for the year 1884-85.

1884-85.	Number of Days.				Number of Negatives.					Number of working days when Solar Phenomena were	
	Negatives were	Failures			Solar Phenomena.						
	When taken.	From bad weather.	From various causes.	Total.	Spots and Faculæ. S^{v} 12^{m}	Spots only.	Faculæ only.	None.	Total.	Visible.	Absent.
October	27	4	...	31	69 ...	...	...	...	69	27	...
November	30	...	...	30	84 ...	...	...	...	84	30	...
December	30	1	...	31	83 ...	...	...	...	83	30	...
January	19	12	...	31	42 ...	...	...	...	42	19	...
February	25	3	...	28	67)	...	...	...	)	25	...
March	28	3	...	31	63)	...	...	...	)	28	...
April	26	4	...	30	61) 75	...	...	...	373	26	...
May	22	9	...	31	53)	...	...	...	)	22	...
June	24	6	...	30	54)	...	...	...	)	24	...
July	16	15	...	31	29 13	...	...	...	42	16	...
August	9	22	...	31	18 5	...	...	...	23	9	...
September	24	3	...	30	63 26	...	...	...	89	28	...
Total	284	81	...	365	687 119	...	...	...	806	284	...

456 silver prints of the 8-inch and 119 of the 12-inch pictures were made.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DUN.

Table of Percentages of daily Visibility of the Sun and the presence of features.

Year.	In 100 days the sun was invisible on	In 100 working days features were present on
1877-78 . . .	9 days (obtained from 273 days).	30 days (obtained from 248 working days).
1878-79 . . .	11 „ „ 89 „	28 „ „ 79 „
1879-80 . . .	14 „ „ 289 „	82 „ „ 232 „
1880-81 . . .	15 „ „ 365 „	96 „ „ 307 „
1881-82 . . .	10 „ „ 365 „	100 „ „ 328 „
1882-83 . . .	13 „ „ 365 „	100 „ „ 318 „
1883-84 . . .	21 „ „ 366 „	100 „ „ 285 „
1884-85 . . .	22 „ „ 365 „	100 „ „ 284 „

Contrasting the percentages of days of invisibility above given with those for Greenwich, as furnished by the Astronomer Royal's Reports, we have—

Year.	At Dehra, year ending 30th September.	At Greenwich, year ending 20th May.
1880-81 . . .	15	60
1881-82 . . .	10	45
1882-83 . . .	13	45
1883-84 . . .	21	41
1884-85 . . .	22	...

An extract from the Greenwich observations for 1883 is subjoined, from which it will be seen how materially (125 days) the Indian photographs helped to supplement the Greenwich series so as to obtain a record for no less than 340 out of the 365 days :—

"The Indian photographs, which have been forwarded by the Solar Physics Committee to fill the gaps in the Greenwich Series, were taken under the superintendence of J. B. N. Hennessey, F.R.S., Deputy Superintendent, Trigonometrical Survey of India, with a Dallmeyer Photo-heliograph giving an image of the sun 4 inches in diameter, for the period from 1883, January 1st to May 20th,* after which another secondary magnifier, giving an image of the sun nearly 8 inches in diameter, was adopted to the photo-heliograph under the auspices of the Solar Physics Committee. In the process adopted at Dehra-Dún bromoiodized collodion has been used in connexion with iron development.

(*Should be 30th.)

"Photographs of the sun were taken at Greenwich on 215 days, and Indian photographs on 125 days were received from the Solar Physics Committee to complete the total of 340 days for which there are either Greenwich or Indian photographs of the sun available in 1883."

Weekly despatches of the negatives and silver prints to the India Office continue to be made as usual.

METEOROLOGY.

With regard to Meteorological observations, no change has been made on the procedure of former years. The results of the observations taken at Dehra twice daily throughout the year have been supplied to the Meteorological Reporter to the Government of the North-Western Provinces and Oudh. Daily weather telegrams were sent from Mussooree to Simla during the six months the office was open at Mussooree, and the anemograms for Mussooree for six months and for Dehra for twelve months have been furnished to the Meteorological Reporter to the Government of India. The usual tables of monthly results and of the mean velocity of wind at Dehra are appended. Another 12 months' observations of deep-sunk earth thermometers have been added to the results exhibited in the table at page CXIV of the Administration Report for 1883-84.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DUN.

Mean Monthly Readings of Deep-sunk Earth Thermometers.

Depths in feet of thermometer below surface of ground.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
		°	°	°	°	°	°	°	°	°	°	°	°
	1881	...	...	...	...	...	73·43	73·09	75·02	76·07	76·03	76·08	*76·71
	1882	75·91	75·13	74·52	74·11	73·97	74·05	74·31	74·95	75·09	76·14	76·29	76·37
25·6	1883	76·55	75·02	74·28	73·69	73·97	73·96	74·32	74·90	75·06	76·16	76·28	76·12
	1884	75·20	74·39	73·90	73·64	73·65	73·95	74·34	76·00	76·97	77·33	†77·27	76·72
	1885	75·63	74·95	74·34	74·00	73·92	74·02	74·75	‡	‡	...	...	...
	1881	...	...	...	...	...	74·87	76·47	77·89	78·98	79·26	§77·71	74·89
	1882	72·33	70·79	70·47	71·70	73·37	75·23	76·87	76·20	76·99	79·42	77·64	74·89
12·8	1883	72·46	70·36	69·83	70·95	73·00	75·17	76·82	78·20	78·97	79·93	76·05	73·80
	1884	70·95	69·75	70·01	71·47	73·39	75·75	77·42	79·21	79·82	79·31	§77·08	74·52
	1885	72·18	70·37	70·03	72·14	73·66	73·99	76·60	76·99	79·42	...	...	...
	1881	...	...	...	...	...	80·05	81·01	80·75	81·24	80·33	76·80	76·38
	1882	67·17	66·05	67·75	72·20	76·47	80·61	80·78	81·30	81·32	80·16	76·75	71·03
6·4	1883	67·64	65·10	66·48	71·00	76·22	79·29	80·20	81·42	81·12	79·50	74·40	69·71
	1884	66·03	65·61	67·95	72·36	76·99	80·76	81·46	81·61	81·10	78·85	73·61	69·57
	1885	66·64	64·83	66·73	71·10	76·29	77·29	80·32	80·77	80·85	...	...	...
	1881	...	...	...	...	...	84·93	83·29	83·03	82·40	79·07	72·39	65·50
	1882	62·57	62·31	67·61	75·49	80·56	84·77	82·71	83·06	82·20	79·21	71·73	66·14
3·2	1883	63·27	60·70	64·83	74·13	81·57	85·14	83·09	83·43	81·71	78·23	69·72	62·50
	1884	61·23	61·90	67·09	75·75	82·32	85·11	84·29	81·94	81·38	76·50	69·23	64·16
	1885	61·38	60·28	65·97	73·53	79·30	82·30	82·68	80·91	81·35	...	...	...
	1881	...	...	...	...	...	80·16	84·14	82·53	83·19	77·91	67·98	60·7
	1882	54·91	59·41	60·59	78·53	84·99	89·24	83·48	84·06	82·59	77·85	67·96	62·17
1·1	1883	57·98	56·43	65·97	79·53	86·65	87·04	84·55	84·89	82·19	76·70	65·41	57·83
	1884	53·23	59·89	69·56	80·14	88·27	85·37	85·69	82·03	81·64	75·14	65·38	60·49
	1885	57·33	57·75	68·23	77·20	78·63	87·22	84·35	81·16	82·00	...	...	...
	1881	...	...	...	...	...	87·65	83·54	81·00	82·66	82·72	75·23	71·19
	1882	66·77	66·51	81·36	88·73	91·04	89·11	81·61	82·40	84·62	83·97	75·04	72·36
Thermometer in shade.	1883	64·80	65·72	75·59	81·83	90·54	90·60	83·54	83·85	82·95	82·00	70·95	66·12
	1884	67·36	68·52	81·32	89·51	97·33	89·60	83·56	79·73	80·30	77·30	71·77	67·37
	1885	61·50	65·44	79·35	85·63	84·67	91·97	83·74	79·08	82·43	...	...	...

* The hole which had gradually filled up about 2½ feet was dug down to the original depth between the 20th and 24th December 1881.
† The hole which had gradually filled up 2 feet since December 1881 was dug down to the original depth between the 9th and 13th November 1884.
‡ Earth fell in from the sides of the holes on the 2nd and 3rd August 1885, and covered the thermometer to the depth of 11 feet.
§ The hole which had gradually filled up 11 inches since June 1881 was dug down to the original depth on the 17th and 18th November 1884.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DUN.

Mean velocity in miles of the winds which blew at Dehra-Dún during the twelve months of 1884-85 for each hour of the day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
0 to 1	2·39	2·54	2·32	1·00	1·71	3·39	2·20	1·59	1·80	0·87	0·67	0·77
1 „ 2	2·29	2·12	1·94	1·53	1·63	2·14	1·87	1·69	1·20	0·52	0·84	0·87
2 „ 3	1·87	1·81	2·03	1·17	1·75	1·93	1·40	1·31	1·33	0·61	0·67	1·02
3 „ 4	1·68	1·65	1·81	1·43	1·88	2·21	1·20	1·52	1·13	0·42	0·47	0·83
4 „ 5	1·68	1·73	1·71	1·37	1·29	1·93	1·07	1·03	1·17	0·90	0·38	0·72
5 „ 6	1·35	1·50	1·52	1·67	1·54	1·64	1·20	1·10	0·93	0·48	0·43	0·63
6 „ 7	1·13	1·35	1·42	1·47	1·08	1·96	1·20	1·03	0·73	0·61	0·47	0·33
7 „ 8	1·00	1·12	1·35	1·32	1·75	1·86	1·17	1·10	0·93	1·06	0·59	0·23
8 „ 9	1·16	1·15	1·45	1·27	1·46	1·79	1·33	1·83	1·23	1·45	1·10	0·43
9 „ 10	1·48	1·31	1·58	1·47	1·71	2·29	1·97	1·96	1·83	2·08	1·39	0·68
10 „ 11	2·13	2·08	1·87	1·63	1·83	2·46	2·23	2·24	1·87	1·84	1·85	0·85
11 „ 12	1·74	2·15	2·29	2·03	2·33	2·71	3·53	3·00	2·80	2·29	1·79	1·02
12 „ 13	2·32	2·73	2·65	2·07	2·50	3·48	3·13	3·03	3·70	2·32	1·45	1·10
13 „ 14	2·87	3·08	2·68	2·57	3·27	3·78	4·23	3·31	3·37	2·68	2·28	1·57
14 „ 15	3·03	2·81	2·87	2·80	3·92	4·08	4·27	3·63	3·83	2·42	1·67	1·80
15 „ 16	2·58	2·15	2·10	2·10	3·40	3·64	3·57	4·28	2·80	2·52	1·69	1·87
16 „ 17	1·22	1·08	1·13	1·90	2·96	3·07	3·70	3·38	3·37	2·32	1·19	1·70
17 „ 18	0·55	0·38	0·45	1·20	1·96	1·39	2·63	3·83	2·53	1·35	0·79	0·93
18 „ 19	2·06	1·42	1·23	1·23	0·75	1·00	1·47	1·59	1·33	0·90	0·43	0·65
19 „ 20	2·71	2·62	2·03	0·87	0·59	1·68	0·73	1·07	1·50	0·45	0·38	1·47
20 „ 21	2·87	3·08	2·48	1·13	1·04	2·11	1·40	1·66	1·33	0·61	0·48	1·05
21 „ 22	2·94	3·27	2·68	1·40	1·63	3·04	2·13	1·83	1·87	0·48	0·69	0·98
22 „ 23	2·84	3·23	2·61	1·57	1·46	2·71	2·80	1·66	1·87	0·71	0·74	0·85
23 „ 24	2·68	2·96	2·45	1·60	1·96	2·46	2·47	2·10	1·87	0·94	0·41	0·92
Sums	48·58	49·32	46·65	37·75	45·69	58·75	52·90	50·77	46·32	30·78	22·65	23·27
Average	2·02	2·06	1·94	1·57	1·90	2·45	2·20	2·12	1·93	1·28	0·95	0·97

Actinometry.—Another batch of six thermometers was received in December 1884. Observations to determine their relation to the standard were commenced, but owing to press of other work these had to be stopped. The comparisons will be resumed as soon as practicable.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA-DÚN.

Monthly Meteorological Results taken from the Register at the Trigonometrical Branch Office, Dehra-Dún.

YEAR AND MONTH.	BAROMETER REDUCED TO 32° FAHRENHEIT.						HYGROMETER.				THERMOMETER.								RAIN.		WIND.	CLOUD.	
	At 9-30 A.M.			At 3-30 P.M.			At 9-30 A.M.		At 3-30 P.M.		Dry Bulb.					Wet Bulb.							
	Highest.	Lowest.	Monthly mean.	Highest.	Lowest.	Monthly mean.	Monthly mean temperature of dew point.	Monthly mean humidity.	Monthly mean temperature of dew point.	Monthly mean humidity.	Maximum in sun's rays.	Maximum on grass.	Maximum in air.	Minimum in air.	Monthly mean temp.	Maximum in wet.	Minimum in wet.	Monthly mean wet.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 9-30 A.M.	At 3-30 P.M.
1884.																							
October	27·885	27·521	27·733	27·830	27·448	27·659	59·0	·742	58·9	·579	100·7	45·3	80·9	53·0	68·4	70·7	49·6	60·6	4	2·45	S. W.	2	3
November	·872	·732	·801	·801	·646	·713	47·7	·666	48·4	·483	90·3	35·0	74·4	44·5	60·0	61·3	41·2	51·7	1	0·05	S. W.	0	1
December	·943	·737	·877	·871	·650	·784	44·7	·713	45·3	·496	83·0	32·9	69·0	40·0	55·9	58·2	37·1	48·7	1	0·00	S. W.	2	2
1885.																							
January	·992	·639	·837	·903	·682	·765	45·9	·788	47·0	·598	82·9	34·2	69·5	39·3	54·7	59·7	37·3	49·4	9	4·68	W. S. W.	6	6
February	·828	·641	·729	·766	·564	·659	42·2	·679	41·7	·451	91·0	31·8	74·4	38·0	55·1	56·1	36·2	46·9	4	1·81	W.	3	3
March	·839	·593	·720	·747	·511	·636	49·8	·545	46·3	·339	106·4	38·9	88·7	46·5	67·3	67·3	41·8	55·5	3	0·20	N. W.	3	4
April	·789	·527	·617	·695	·439	·536	52·7	·461	50·9	·339	111·7	48·5	93·2	56·0	74·2	68·0	49·9	59·3	6	0·74	Calm	3	4
May	·707	·518	·596	·664	·459	·527	57·3	·523	55·0	·408	113·3	51·6	93·7	59·3	74·7	70·7	51·8	62·5	11	4·74	N. N. W.	4	5
June	·603	·235	·424	·532	·161	·341	65·0	·550	64·3	·466	124·3	56·7	102·7	66·5	83·8	78·5	56·1	69·9	10	14·12	N. W.	3	4
July	·492	·260	·376	·461	·194	·319	73·9	·832	74·8	·771	112·6	67·8	92·2	70·6	80·0	81·9	68·1	74·9	25	18·20	Calm	7	7
August	·566	·337	·423	·462	·267	·355	73·0	·874	74·2	·860	112·8	67·1	87·9	70·1	77·4	79·0	68·5	73·9	20	64·39	S.	8	9
September	·750	·410	·577	·649	·341	·498	68·7	·772	69·9	·692	109·0	58·4	86·3	64·6	76·7	29·5	60·0	70·1	12	7·02	E. N. E.	3	6

O. I. C. P. O.—No. 23 S. G.—6-5-86—425

Circular No. $\frac{40S.}{36—9}$

Extract from the Proceedings of the Government of India, in the Revenue and Agricultural Department (Surveys),—under date Simla, the 21st June 1886.

READ—

The General Report on the Operations of the Survey of India Department for the year 1884-85.

RESOLUTION.

Personnel.

The administration of the Department during the year remained in the hands of Colonel G. C. DePrée, B.S.C., who also held direct charge of the working of the Topographical Branch. The Revenue and Trigonometrical Branches were superintended, respectively, by Lieutenant-Colonel H. R. Thuillier, R.E., and Colonel C. T. Haig, R.E.

2. Part II of the Report contains detailed accounts of the operations of the several survey parties.

Triangulation.

3. The work of the Secondary Triangulation Party extended over about 240 miles of coast line from near Berhampore to the mouth of the Godávari. An area of 1,240 square miles was traversed, 600 miles of which were covered with fresh triangles; the positions of 20 beacons were determined, and 4 light-houses and 83 permanent and conspicuous objects were fixed.

Topographical Surveys.

4. Topographical surveys were conducted by 12 parties, of which 4 were employed in Bombay, and one each in the Andaman Islands, Assam, Baluchistan, Central India, Mysore, Rajputana, the North-Western Provinces, and British Burma. The operations generally were continued in the same districts as in the previous year, the only changes being the suspension of topographical operations in the Aligarh district of the North-Western Provinces, the party being transferred for revenue work elsewhere, and the introduction of topographical survey into the Shwegyin district in British Burma when cadastral operations came to an end.

Andaman Islands party.

5. In the Andaman Islands triangulation was extended as far as the Middle Island, covering an area of 1,000 square miles, and including the station on Saddle Peak in the North Andaman Island. About 900 square miles remain to be triangulated. Surveying in detail was completed with considerable difficulty over an area of 111 square miles on the scale of 4 inches = 1 mile, and 670 square miles were surveyed on the $\frac{1}{2}$ inch scale. The outturn is satisfactory, considering the difficulties which the party had to encounter, and the Governor General in Council concurs in the Surveyor General's opinion that it reflects credit on Captain Hobday and the party under his orders.

Assam and North-Eastern Frontier party.

6. An exploration party under Colonel Woodthorpe, with a small escort of the 44th Assam Light Infantry under the command of Major C. R. MacGregor, and accompanied by Mr. T. D. LaTouche of the Geological Survey Department and Surgeon D. St. J. Grant, triangulated and surveyed a large tract of the Singpho hills lying to the east of the Great Trigonometrical stations Jaitu, Maiobúm, and Maiúm, and extending to the Mile Kha river in the Bor Kampti country. The tract embraces country both north and south of the Dihing (or Diyun) river. One of the objects of the expedition was to obtain particulars regarding possible trade routes to Burma and China. Neither of the two

passes explored by the party could be rendered fit for the purpose without considerable expenditure. The party added much to the scanty knowledge previously possessed of the geography of these hills. The work done was arduous, and involved much difficulty and hardship. His Excellency in Council is glad to avail himself of this opportunity to acknowledge the good service rendered by Colonel Woodthorpe, Major MacGregor, and the officers and men associated with them.

The Baluchistan party.

7. The regular survey of the Baluchistan agency on the scale of $\frac{1}{2}$ an inch to a mile was continued; the frontier survey was extended up to Dera Gházi Khán, and a large area beyond the British frontier was reconnoitred by a small detachment of the survey party accompanying the Zhob Valley Field Force. The personnel of the party was subject to several changes and some reduction, and, owing to this cause and to unfavourable weather, the outturn of work was less than in the previous season. 7,717 square miles (including 2,320 square miles of reconnaissance) were surveyed topographically on the $\frac{1}{2}$ inch scale between the Sulemán range on the east and the Khelát hills on the west.

The Cutch party.

8. The party employed on the Cutch survey accomplished 754 linear miles of traverse, 1,641 square miles of topographical survey on the scale of 2 inches = 1 mile, 612 square miles on the $\frac{1}{2}$ inch scale, and a small area in the city and cantonment of Bhuj on the scale of 12 inches = 1 mile. It is expected that the Cutch survey will be completed during the current year.

South Deccan, Gujarát, and Konkan parties.

9. The three other Bombay parties carried on topographical surveys in the South Deccan, in Gujarát, and in the Konkan and Southern Maratha country. Besides topographical work, consisting of 1,662 square miles on the 2 inch scale, the triangulation of 2,467 square miles and the traversing of 1,108 linear miles, the South Deccan party completed the survey of the town of Pandharpur on the scale of 80 inches = 1 mile. The Gujarát party suffered much from sickness, but accomplished 2,162 square miles of triangulation, 445 linear miles of traverse, and the topographical survey of 1,711 square miles on the 2 inch, and 22 square miles on the 4 inch, scale. The completion of the work before this party is estimated to take about 5 years. The Konkan party was employed in the Thána and Kolába districts and in the Southern Maratha country near Belgaum, and surveyed topographically 483 square miles on the 4 inch scale in the Thána district for the Forest Department, and 566 square miles in Kolába and in the Jawhár State on the scale of 2 inches = 1 mile. 519 linear miles were traversed, and a considerable area was triangulated preparatory to detailed survey in the ensuing year. The party has completed its work in the Thána district.

The Malwa party.

10. The Malwa party was employed in the Dúngarpur and Oodeypore States of Rajputana and in the Independent States of the Mahi Kántha Agency in Bombay. It surveyed in detail 1,157 square miles on the 1 inch scale, the city of Dúngarpur (6 square miles) on the 6 inch scale, and the Kherwára Cantonment (4 square miles) on the 12 inch scale. The work of this party has now been completed, and it has been transferred for revenue work to the Central Provinces.

The Mirzapur party.

11. The work done by the Mirzapur party consisted of 543·2 square miles surveyed on the 2 inch scale, and 411 miles of boundary traverses. The country was for the most part difficult. Two soldier surveyors were attached to the party as students, and gave much satisfaction.

The Mysore party.

12. The Mysore party completed its triangulation of the entire State, executed 24·2 miles of traversing with the theodolite, and surveyed topographically 2,365 square miles in the Mysore district on the scale of 1 inch = 1 mile. The present year will probably bring the work of this party to a close.

The Rajputana party.

13. The revised survey of Ajmere on the scale of 12 inches to the mile having been completed, the Rajputana party made a detailed survey on the 6 inch scale of the cities of Jeypore and Amber and of the surrounding hills,

covering 77·3 square miles. 1,808 square miles were also surveyed topographically in the Jodhpur State and parts of Sirohi and Pálanpur. Two military students were attached to this party and learnt their work well.

Shwegyin party, British Burma.

14. The party employed in Shwegyin, of which financial exigencies had compelled the transfer from revenue work, was reorganized, commenced topographical work in the north of the same district, and, in continuation of the area cadastrally surveyed in previous years, covered 1,142 square miles on the scale of 2 inches = 1 mile. The party has since been transferred for revenue work to the Central Provinces.

Forest Surveys, British Burma.

15. The Burma Forest party was split up into three camps, and traversed an area of 500 square miles. It also triangulated 814 square miles in the Prome and Toungoo districts. Of 314 square miles of reserved forests surveyed topographically on the 4 inch scale, and of 44 square miles of unreserved forests surveyed on the 2 inch scale, nearly the whole was situated in the Tharrawaddy district. The work of the party has throughout been attended by considerable difficulties.

Cadastral Surveys.

16. Six entire cadastral parties and one detachment were employed in the year under report,—two in British Burma, one in Assam, and two and the detachment in the North-Western Provinces. Of these parties, two—those in the Dehra Dún district of the North-Western Provinces, and the Henzada district in British Burma—have completed the survey work assigned to them.

Ajmere-Merwara.

17. The cadastral survey of *khalsa* villages in Ajmere-Merwara, comprising an area of about 1,200 square miles, was continued and finished on the same system as in the previous year. The officer in charge of the survey also undertook the permanent demarcation and the instruction of the district staff in cadastral surveying. Major Steel's report on this subject is very satisfactory.

Akyab and Bassein-Henzada Surveys.

18. In British Burma two parties were employed in the Akyab and in the Bassein and Henzada districts respectively. In Akyab 562 square miles were surveyed cadastrally on the 16 inch scale, 70 square miles of river on the 2 inch scale, and 2¼ square miles of the Akyab city on the 64 inch scale. The permanent demarcation of the traverse stations was effected to provide for accurate mapping hereafter of new cultivation by the local supplementary survey establishment. The training of indigenous surveyors was carried on as usual in Akyab, but it is reported that the boys taught betake themselves, after receiving certificates, to more lucrative employment. The cadastral survey of the remainder of the district (exclusive of those portions which, being useless for settlement purposes, will not be surveyed) will occupy about 2 years. In the Henzada and Bassein districts the only work done was the completion of the area of 900 square miles remaining for cadastral survey. The party has been withdrawn since the close of the year.

The Basti party.

19. Cadastral survey operations and the preparation of the record-of-rights were conducted in parganas Amorha, Nagar, and Basti. The survey of river-side villages in the Fyzabad district was also completed on the right bank of the Gogra river as far as the cadastral survey on the Basti side had been executed in previous years. The system of survey was the same as before, though some changes were made in the manner of writing up the village records by the introduction of a modified form of the Benares system. The work done consisted of the cadastral survey on the 16 inch scale of 666·58 miles in Basti, and of the *mauzawár* survey on the 4 inch scale of 69·81 miles in Fyzabad. The cost of the combined work of survey and of compiling records and assessment statistics is Rs. 229-13-8 a square mile, the rate being higher than that in Gorakhpur owing to the relatively larger number of fields comprised in the area surveyed.

Gorakhpur party.

20. The cadastral survey of the Gorakhpur district was continued on the same system as in the previous year, and extended over 747·37 square miles in Gorakhpur on the 16 inch scale, and 92 square miles of *manzawár* survey in Azamgarh on the 4 inch scale. Certain changes have been introduced in the division of labour between the Survey and Settlement Departments, which, though somewhat increasing the work of the former, will, it is hoped, lead to improved results from the combined efforts of the two departments. The cost of survey operations alone during the past year was Rs. 171-2-0 a square mile.

Kámrúp party.

21. The work of the Kámrúp party was continued along the right bank of the Brahmaputra river, 478·05 square miles being completely surveyed, and the preliminary boundary traverses being executed of 772 square miles. No change was made in the system of survey. The party suffered considerably from fever, and difficulty was experienced in keeping it up to its proper strength. The cost of survey operations amounted to Rs. 220-11-1 a square mile.

Punjab party.

22. The objects with which surveys are now being carried out in the Punjab are thus described : (*a*) To furnish a basis for and check on the *patwári* measurements under progress in the Sub-Himalayan districts; (*b*) to obtain revised topographical maps by utilizing settlement maps prepared by *patwáris* ; and (*c*) to carry out the survey of riparian tracts subject to fluvial action. To this end the following plan of operations for future surveys in the Province has been agreed upon between the Survey and Settlement Departments :—

(1) that an attempt should be made to construct topographical maps from the *patwári* maps on the basis of the old professional survey traverse data in districts recently surveyed by the *patwári* agency ;

(2) that in districts of which no *patwári* survey has yet been made skeleton traverses should be run, fixing as a minimum two points in each village to serve as checks on the *patwári* measurements, and as a basis on which topographical maps can in future be framed from the *patwári* maps ;

(3) that the topographical maps should be locally tested, and the details corrected and compiled where necessary.

Following this procedure, the party completed the traverse survey of the whole of the Ferozepore district and about two-thirds of the Umballa district.

The result of the season's work shows that *patwáris'* maps can be utilized for the framing of topographical maps on a small scale, when fixed points are established by professional traversing, though it also shows the necessity for the fixed points required to fit the village maps together comprising all the village trijunctions. The aggregate cost of traverse survey and compilation of *patwári* maps, local test, and fair mapping has amounted to Rs. 18-7-6, or about two-thirds of that of a new survey. The Deputy Superintendent in charge hopes that this expenditure may be further reduced. The results already attained are creditable, and have been acknowledged by the Government of the Punjab.

Central Provinces.

23. The detachment which had been employed in the previous year in Raipur was, during the year under report, engaged in the survey of the Sambalpur district on the "field block" system, which was fully described in the last report. Another detachment was formed in Raipur for instructional purposes, the result being that three Assistant Commissioners, four District Revenue Inspectors, 69 Revenue Inspectors, and 319 *patwáris* were made efficient in survey work. The outturn of work in the Sambalpur district amounted to 499 square miles on the 16 inch scale, the average size of the blocks being 95 acres. Preparatory traverses were also extended over 104 square miles. The season was unhealthy, and the party suffered considerably. The total cost of operations was Rs. 58-4-7 for combined traverse and boundary survey.

Geographical and Miscellaneous.

24. The work of the Himalayan, formerly called the Darjeeling, party consisted of (1) the survey of the Daling hills; (2) the demarcation of the Nipál boundary; (3) the mapping and computations connected with the Nipál boundary survey, the Sikkim triangulation, and the revisionary survey of Darjeeling; (4) the triangulation of the Simla Hill States; and (5) the geography of the Himalayas. In the Daling hills the blocks of land set apart for tea cultivation were demarcated with permanent pillars. On the Nipál Frontier, a topographical survey on the 1 inch scale was executed along the Gandak river, and a re-survey was made of the Mechi river with a view to the re-arrangement of the boundary. A ditch was also dug along those portions of the boundary which were surveyed last year. The attention of the Governments of Bengal and of the North-Western Provinces and Oudh will be invited to the necessity for looking after this landmark. The triangulation of the Simla Hill States was effected between Kalka and Simla westwards of Dagshai and Sabáthu. Sufficient materials have now been obtained for mapping the geography of the Mahabarat range from Tribeni to Darjeeling, and of all the ridges north of the Mahabarat which are visible from the plains. Data have also been collected for rectifying a considerable amount of the geography of Upper Bhután. A careful exploration by R———N———has added much to the knowledge hitherto possessed of the neighbourhood of Kinchinjanga. Interesting extracts from Colonel Tanner's narrative report of his exploration in Eastern Kumaon and from R——— N———'s narrative are appended to the report.

Tidal observations.

25. Of the 19 tidal observatories which were in working order during the previous year, two—at Beypore and Vizagapatam—were closed, their equipment being transferred to new stations at Cochin and Coconada. The False Point Observatory was destroyed by a cyclone, and will not be re-erected. The tide tables for 1886 contain the predictions of high and low water at 23 ports, or three more than last year—Galle, Colombo, and Marmagao being the new ports added. The predictions made at the open coast stations were very accurate in respect both of the time and the height of the tides.

Spirit levelling operations.

26. The spirit levelling operations consisted of a double line from Madras along the railway line to Beypore, with a branch from Jalárpet Junction to the Bangalore base line, and of two lines of connection between the Madras and Beypore tidal stations, and the erection of two pairs of test bench marks. A levelling party was also employed with the Revenue Survey party in the Henzada district.

Geodetic.

27. Owing to the transit instrument being under repair and to the want of a second officer trained to use the electro-telegraphic longitude apparatus, operations were suspended during the year, and the observations for astronomical latitudes with the zenith sector, in abeyance since 1871-72, were resumed. The reduction of the observations taken was not completed during the year. One Astronomical party was engaged in taking observations for direct latitudes at eight stations of the Amúa Series of the Great Trigonometrical Survey.

Head-Quarters' Offices.

28. The account, given in Part III, of the work of the Drawing, Engraving, Photographic, and Lithographic Offices, and of the Mathematical Instrument Depôt at Calcutta, has been read with interest. Much progress has been made, especially in the Photographic Department.

The total number of maps issued was 235,636, valued at Rs. 1,86,380. These figures, compared with those for the preceding year, show an increase of 36,579 in number and of Rs. 13,858 in value. An arrangement which will, it is hoped, conduce to economy has been introduced since the close of the year. Under it Local Governments and Departments will be charged for the work done for them and for maps supplied by the Survey of India.

Among maps undertaken on special requisition were (1) a railway and road map of the North-West Frontier as far as Quetta, (2) a map showing the distribution of the principal religions in India, and (3) a large skeleton map of

India. The last of these, as well as an elaborate model, based on the 32 mile map of India, showing all the hills of which the scale admits, was prepared specially for the Colonial and Indian Exhibition.

Besides the issue to other departments of 27,643 instruments valued at Rs. 1,61,590, to additional work amounting in value Rs. 12,437 was done by the Mathematical Instrument Office. A thorough and much-needed stock-taking of the instruments and stores in the depôt was effected.

Dehra Office.

29. The Computing Office at Dehra made good progress with the reduction of the operations of the Great Trigonometrical Survey.

The pictures of the Sun obtained with the photo-heliograph were much more satisfactory during the year under review than in 1884.

30. In conclusion the Government of India desire to acknowledge the good work which has, as usual, been done by the Survey Department during the year under review.

ORDER—Ordered, that the above Resolution be forwarded to the Local Governments and Administrations named in the margin, and to the Surveyor General of India and to the Foreign and Military Departments for information.

Madras.	Punjab.
Bombay.	Central Provinces.
Bengal.	British Burma.
North-Western Provinces and Oudh.	Assam.
	Coorg.

Ordered also, that it be published in the Supplement to the *Gazette of India*.

(True Extract.)

C. J. LYALL,

Offg. Secretary to the Government of India.

FILE No. 36.
SERIAL No. 9.

1886.

GOVERNMENT OF INDIA.

REVENUE AND AGRICULTURAL DEPARTMENT.

SURVEYS.

RESOLUTION.

Circular No. 40S. / 36—9

Dated Simla, the 21st June 1886.

SUBJECT.

Remarks on the Report of the Operations of the Survey of India Department for 1884-85.

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